The Glass Industry

REG. U. S. PAT. OFF

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American Ceramic Society

Twenty-seventh Annual Meeting

The twenty-seventh annual meeting of the American Ceramic Society opened February 16 in the chapel of the Ohio State University, Columbus, Ohio. The opening program was in the nature of a celebration of the thirtieth anniversary of collegiate training in ceramics, which had its birth in 1894 in this same institution.

E. A. Hitchcock, dean of the College of Engineering, presided, and an address of welcome was presented by President W. O. Thompson who encouraged the visitors to inspect the many new laboratories and class room buildings about the campus.

Edward Orton, father of ceramic education in this country, spoke on events leading up to ceramic education in the United States. He gave as the source of his inspiration and determination to establish such a school, the difficulties which he had experienced in applying general fundamentals of physics and chemistry without detailed knowledge of the special materials with which he was working. These experiences he obtained in the manufacture of paving brick. He was very modest, however, regarding the difficulties he overcame in accomplishing his program.

Dr. Orton was followed by A. V. Bleininger, who discussed the progress of ceramic education in the past thirty years. No one has been so active in controlling or directing programs of progressive research as has Dr. Bleininger. He was one of Orton's first students and has been a leader in the scientific development of ceramics ever since.

Dr. Bleininger stated that much of the early scientific information regarding silicates was the work of metallurgists in this country, who developed the use of the empirical formulas for calculating ceramic mixtures, and began the comparison of the properties of these mixtures on the basis of their oxygen ratios. Much of the early literature was also the product of geologists who knew considerable of silicate chemistry but had not given the ceramic industry much thought in its application.

Dr. Tillotson predicted an ever increasing demand for men trained in ceramics, and stated that nearly every industry was dependent on the use of ceramic materials in their operations, and should have a ceramic engineer familiar with these materials as part of its technical staff.

General C. M. Mitchell spoke of the need of a ceramic school in Eastern Canada and stated that he was present to get assistance in starting such an institution.

President Landrum's address contained much information regarding the ceramic schools organized in this country and their attendance.

The annual banquet held Tuesday evening was a record breaking affair and a wonderfully delightful and entertaining evening was enjoyed. Lawrence E. Barringer acted as toastmaster and the following talks were heard:

Engineers' Need of Fundamental and Cultural Education—Dr. W. O. Thompson.

Difference in Viewpoint and Attack of the Engineer and Scientist—Dean E. A. Hitchcock.

The Interdependence of Universities, Bureaus and Industrial Laboratories—Prof. George H. Brown.

The Spirit of "96"—Dr. W. L. Evans.

Education Backwards—Ross C. Purdy.

Installation of Officers—Dr. Edward Orton, Jr.

The annual election resulted as follows:

For president, E. Ward Tillotson, assistant director, Mellon Institute; vice-president, Frederick H. Rhead of American Encaustic Tile Company; treasurer, H. B. Henderson of Standard Pyrometric Cone Company; secretary, Ross C. Purdy.

Tuesday and Wednesday were devoted to meetings of the various industrial groups. The Glass Division meetings were well attended and interest in the program was such that it could not be completed in the time allowed.

The program consisted of twenty-two papers, including a joint symposium with the Refractories Division on glass house refractories.

Owing to limited time it was impossible to have the balance of the program not related to refractories presented. The refractories symposium was a very interesting session, which covered both the theoretical and practical aspects of the use and improvement of refractories.

J. C. Hostetter of Corning Glass Works presided at the meeting and Dr. Sosman started the program with "Some Fundamental Principles Governing the Corrosion of a Fire Clay Refractory by a Glass." In this discussion Dr. Sosman went back to the very fundamental conceptions of the problem.

Emphasis is placed on the important distinction between *equilibrium* and *rate of reaction.* The occurrence of any reaction is determined by the value of the quantitative propery called δ which can be found by means of measurements of latent and specific heats. This quantity also determines the number of phases present at equilibrium and the way in which the equilibrium changes with temperature. The number and the character of these phases depend upon the composition of the chemical system made up of glass and refractory: The problem in the corrosion of a pot or tank by a lime-soda glass, for example, is a problem of the crystalline phases in equilibrium at a certain temperature with an aluminous liquid phase in the four-component system SiO_2 Al_2O_3 CaO Na_2O.

The rate at which progress is made toward the attainment of this equilibrium is determined mainly by the rate of *diffusion,* which in turn depends upon the viscosity of the liquid glass. Mechanical factors, such as steady or turbulent flow, must also be considered. When equilibrium is attained chemical corrosion of the refractories will cease. Refractories should be made, therefore, of the equilibrium product, or such that the equilibrium product will be a refractory and remain in place.

Dr. McCoughey, mineralogist of Ohio State University, discussed Dr. Sosman's paper in a very interesting manner and emphasized the fact that a perfect refractory should be a perfectly crystalline rock containing the equilibrium compounds which are formed between glass and clay. The time factor required to develop such a refractory in place is however too great. The condition might be attained by making the bond of a refractory of unstable material which would form an even better bond when brought to equilibrium. Dr. McCoughey stated that whenever he examined refractories which the furnace man pronounced as good they usually consisted of a perfectly crystalline bonded rock constituted chiefly of the equilibrium product whether it be silica brick or clay brick.

Dr. McCauley, Corning Glass Works, discussed the mathematics of heat losses through clay blocks by convection and radiation. He gave formulas for calculating these values which will appear in the article to be published in the *Journal of the American Ceramic Society.* He shows that the radiation losses are considerably greater than losses by convection currents.

R. J. Montgomery discussed the subject "Present and Future Walls for Use Against Molten Glass."

The early glass pot was made of German clay, which, because of its lack of refractories, was later mixed with Missouri fire clay. The war made it necessary to substitute American bond clay for the German which was still used. The batch drifted from one of high silica, such as that obtained with all German clay, to one of comparatively low silica without its being realized. While German clay is now available, it is recognized to be unnecessary.

Aside from going back to a high silica pot and the use of porcelain pots for special glasses, little progress has been made in pot composition. The pot of the future will probably be of clay, but of white firing clays, carefully selected. The structure will be uniform rather fine grained with greater refractoriness, depending upon greater freedom from impurities. Its chemical composition will be suited to the composition of the glass melted and the temperature of the furnace. The density will be under control and will depend upon the fluidity of the glass at the temperature of melting.

He further stated that at present four types of glass pots were now on the market.

1. German clay, blended with American.
2. American clays blended. No German.
3. American clays blended. High silica batch.
4. Porcelain type pots using American clays. Further, that it was not the individual clays used by the properties of the blended combinations which are important. He also brought out the almost hopeless possibility under these con-

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E. WARD TILLOTSON
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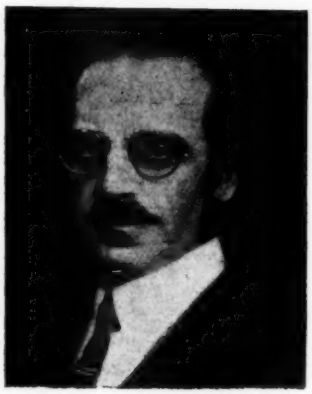
Retiring President



F. H. RHEAD
Vice-President

ditions of any definite specifications as chemical composition and porosity of pots do not produce any definitely related properties of life or resistance to corrosion.

F. S. Thompson presented a paper in the early part of program on "Tank Blocks." Mr. Thompson showed tables comparing the composition, porosity and slagging tendency of various commercial blocks. The table indicated that high alumina mixtures were probably the most resistant to softening when mixed with glass, even though they might be the most porous.

A description of the results of a microscopic examination of deposits on checker bricks by H. E. Insley gave valuable

curve, which shows an increase in life of from 13.58 melts to 16.29 melts per pot or about 21 per cent. These figures show very considerable economy in arching of pots due to treating the problem in a scientific manner.

It was with considerable regret that time did not allow a completion of the program but all papers on the program will appear in complete form during the year in the Society *Journal*.

There is much interest in the development of a method of composition control more rapid than chemical analyses. This is chiefly in the use of values of the physical properties of the glass such as density and coefficient of expansion. A

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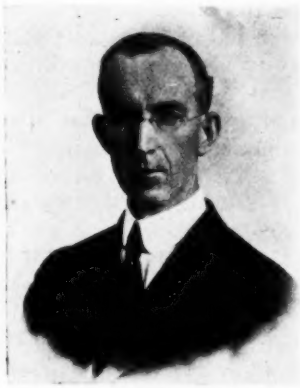
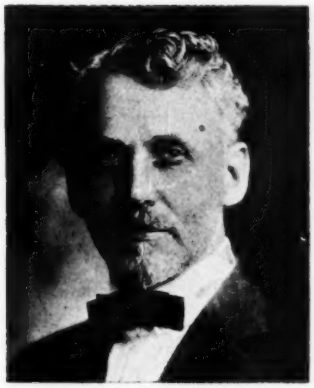


H. B. HENDERSON
Treasurer



ROSS C. PURDY
Secretary

ALEXANDER SILVERMAN
Chairman, Glass Division

and exact information as to the nature of these deposits and how they react with the refractory.

The following is a schematic presentation of the different portions of a high alumina checker brick in a checker run at temperatures between 2,000° F. and 2,200° F. and where the batch dust was high in silica, alkalies, lime and alumina.

Outer surface—Coral like zone:
1. (Na_2O, Al_2O_3, $2SiO_2$) Nephelite, also a little corundum.
2. Glass and (Al_2O_3 corundum, glass corundum and a little $3Al_2O_3$, $2SiO_2$) mullite.
3. Vitrous border zone mullite, and a little glass.

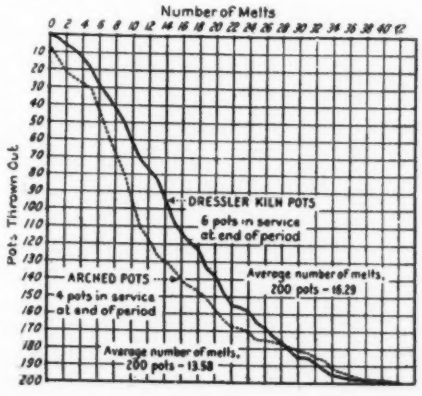
Interior:
4. Mullite, corundum and a little glass.

"The Use of Muffle Tunnel Kilns for the Arching of Plate Glass Pots" by Philip Dressler and L. T. Stroumer.

Muffle tunnel kilns have now been in use for five years for the purpose of preheating or arching of plate glass pots. The use of this type of equipment has brought about substantial savings in labor or fuel and has increased the average life of the pots by approximately 20 per cent. The actual amount of fuel required in the old method of arching was given as 2,200 cu. ft. of natural gas per pot while the fuel consumption of the different tunnel kilns reported varied from 4,600 to 8,000 cu. ft. a fuel saving from 63 per cent to 79 per cent.

The gain in pot life is best shown by the accompanying paper by C. D. Spencer of the National Lamp Works of the

General Electric Company on "Density Variations in Soda Lead Glass and Soda Lime Glass" gave interesting data on this kind of work. He presented the results of the application of the hydrostatic method for determining the density of specimens of glass when applied to a mass of glass between


Number of Melts
Pots Thrown Out
DRESSLER KILN POTS
6 pots in service at end of period
Average number of melts, 200 pots - 16.29
ARCHED POTS
4 pots in service at end of period
Average number of melts, 200 pots - 13.58

25 and 50 grams. His general conclusions of the work are that:

1. This method is capable of precision of about plus or minus five units in the fifth decimal place of the density number or about 1 part in thirty thousand.

2. The variation in density to be expected in a commercial soda lead glass produced in pots is about plus or minus one unit in the second place of decimals in the density number.

3. The variation in density to be expected of a commercial soda lime glass produced in tanks is about plus or minus 5 units in the third decimal place of the density number.

4. The great density variation between different boots in the same day is about one unit in the third decimal place.

5. The density of the glass on two tanks on which accurate data were kept increased slightly during the life of the tank. The variation in density mentioned under 2 and 3 are for the period of one year or the life of the tank. The variation in density from top to bottom of a tank when cold was about one point in the third decimal place.

This interesting paper was followed later by another paper on density by A. N. Finn of the Bureau of Standards. This paper treated of the relation "Specific Gravity vs. Composition of Glass." Mr. Finn has taken the work of Schott and of English and Turner and has developed a method of calculating the density values of these glasses which is apparently more useful than the older method. His general conclusions to date are that the density of the glasses of the soda-lime series and also some others may be computed with greater accuracy and over a wider range of compositions than by previously reported methods.

The relations deduced are expressed by the formulae

$$D = d_1 + d_2 + d_3 \text{ and}$$
$$d_x = m\ (p)^n$$

in which D is the density of the glass, d_1, d_2, d_3 are the partial densities due to constituent oxides, p is the percentage of the corresponding oxides and m and n are constants which differ for each oxide. The values of m and n for silica, soda lime, magnesia and alumina are given in Table II below.

Similar equations show a satisfactory relation between index of refraction and composition when the constants given in Table III below are used.

TABLE II

$D = p_1 d_1 + p_2 d_2 + p_3 d_3 + \ldots\ldots\ldots\ldots\ldots\ldots 100\%$
$d_x = m\ (p)^n$

	m	n	p	Computed	Observed
SiO_2	0.3325	0.4463	p-30	2.214	2.213
Na_2O	.01869	1.081	p	2.715	2.55?
CaO	.03365	0.9887	p	3.310	3.08-3.33
(CaO)	(.02813	1.035	p plus O.2)	3.195	
MgO	.3017	0.9262	p	2.148	3.47-3.64
Al_2O_3	.00675	1.3571	p plus 3	3.640	3.85?

TABLE III

$N_d = p_1 n_1 + p_2 n_2 + p_3 n_3 + \ldots\ldots\ldots\ldots\ldots\ldots 100\%$
$n_x = m\ (p)^n$

	m	n	p	Computed	Observed
SiO_2	0.03875	0.8063	p-10	1.4587	1.4585
Na_2O	.01406	1.0193	p	1.5369	
CaO	.01332	1.069	p plus 1	1.8516	1.725-1.83

A CAUSE OF FAILURE OF THERMOCOUPLE PROTECTION TUBES BY H. E. INSLEY. Porcelain thermocouple protection tubes endure for comparatively short times in glass furnace atmosphere at temperatures from 1,400° C. to 1,500° C. There are on the other hand various disadvantages of using too heavy protection.

Dr. Insley gave the results of petrographic studies so exposed in the melting furnace at the Bureau of Standards. As a result of his observation he made the following general conclusions:

POSSIBLE IMPROVEMENTS IN THERMOCOUPLE PROTECTION TUBES. The microscopic evidence shows clearly that the action of the dusts and gases in the furnace atmosphere on the thermocouple tubes causes the formation of a liquid (glass at ordinary temperatures) and corundum (Al_2O_3). Analyses made on refractory clays exposed to the same conditions[3] show that the glass is relatively high in silica. The formation of this glass which is a mobile liquid at furnace temperatures is apparently the cause of the failure of the tubes.

A possible method for preventing the formation of a large amount of silicate liquid at once suggests itself, that is, increasing the ratio of alumina to silica in the unused tube so that only enough silicate liquid is formed after the reaction with the soda in the furnace atmosphere to form a matrix in which the excess alumina may crystallize. With this in view a batch was made up of calcined alumina, ball clay and feldspar in such proportions that the body would have a composition of approximately 14 per cent SiO_2, 85 per cent Al_2O_3 and 1 per cent of alkali. The body cast satisfactorily yet was somewhat weak in the dried state and showed excessive shrinkage when burned. A tube of this composition was placed alongside the usual type of tube in the pot furnace at the bureau. At the end of the melting period the tube was somewhat deformed but still intact while the other tube had cracked badly and pieces of the outer layer had spalled off. There was no trace of the spalling action and no cracks in the high alumina tube but the surface was crusted over with minute corundum plates. Through the kindness of A. R. Payne of the Hazel-Atlas Glass Company another tube of the same type was placed in a tank melting bottle glass. The tube was mounted without protection in the end of the tank about midway between the two filling-in dog houses, 18 inches above the glass line and projecting 6 inches into the tank. The tube lasted about five days after the temperature had reached about 1,430° C. and two days after the filling with batch had begun. According to Mr. Payne's statement this is about the average length of life of the ordinary pyrometer tube. It was thought, from the appearance of the tube used in the bureau furnace, that failure might have been caused in part by mechanical weakness. It is now planned to make up a batch eliminating the feldspar and substituting "fused" alumina for calcined alumina. It is of course possible that the substitution of other refractory oxides, such as zirconia, for alumina may make a satisfactory pyrometer tube for glass melting furnaces.

Thermocouple protection tubes used in glass furnaces fail much more rapidly than the same tubes used in the ordinary ceramic kilns even though temperatures may be practically the same. Microscopic examination of the thermocouple tubes used in glass furnaces shows that the reaction of the volatilized alkalies and the alkaline dusts with the aluminum silicates of the thermocouple tube causes the formation of a liquid with a composition approaching the formula $Na_2O.Al_2O_3.5SiO_2$. In this liquid excess alumina crystallizes as corundum. Failure of thermocouple

[3]Wilson, Jour. Soc. Glass Tech. 2, 197-213, (1918).

protection tubes in glass furnace atmospheres may take place in two ways: (1) if the reaction between the alkalies and the furnace atmosphere and the aluminum silicates of the tube takes place for only a short time the reaction liquid may occupy only the outer layer on the hot end of the tube. The solidified liquid has a different thermal coefficient of expansion than the interior of the tube and cracking and breaking take place during cooling. If the reaction takes place uninterruptedly at high temperatures the liquid formed drips away and the tube is actually corroded.

The use of much higher percentages of alumina in the tubes than have heretofore been used is suggested in order that after reaction with the alkalies there may be a large amount of crystalline corundum on the surface of the tube and a small amount of liquid silicate.

THE ACTION OF ARSENIC COMPOUNDS ON TANK BLOCKS BY D. J. MCSWINEY. Mr. McSwiney gave the opinion, as the result of his observations, that the present short tank life was largely due to the use of arsenic with selenium rather than to the selenium itself or any changed condition of heat transmission different than that prevailing in manganese glass.

He based his assertions largely on the fact that tanks of green glass which contained no arsenic consistently show a longer life than flint glass tanks decolorized with selenium and using arsenic. He also stated that tanks using 5 pounds of arsenic per ton of sand showed an average life of 8 months while tanks using 3 pounds of arsenic showed an average life of 12 months. As these comparisons were made on tanks drawing about the same tonnage temperature differences cannot very well be given as the cause.

A TEST FOR DETERMINING THE WELDING PROPERTIES OF GLASS BY R. J. MONTGOMERY. Mr. Montgomery stated that in his experience the bending test to show the differences in expansion which is done by welding two strips of glass together and drawing them to a thin rod does not indicate the relative possibility of their making good welds. He shows that it is necessary for glasses to have similar annealing temperatures or ranges to produce satisfactory welds rather than coefficients of expansion.

Those Present at the Glass Division Meetings

G. R. Shelton, University of Saskatchewan, Saskatoon, Canada.
C. B. McComas, Carr-Lowrey Glass Co., Baltimore, Md.
A. R. Payne, Hazel-Atlas Glass Co., Clarksburg, W. Va.
R. J. Montgomery, Bausch & Lomb Optical Co., Rochester, N. Y.
C. E. Fulton, Pittsburgh Plate Glass Co., Creighton, Pa.
F. M. Bell, Student Ceramic Engineering, Columbus, Ohio.
A. R. Hershberger, Student, Cer. Eng. O. S. U., Columbus, Ohio.
Walter Knothe, St. Louis, Mo.
Wm. R. McCleary, Jefferson Glass Co., Follansbee, W. Va.
J. S. Herzog, Thompson Foundry & Eng. Co., Newark, Ohio
W. J. Ingler, Holophane Glass Co. Newark, Ohio.
Wm. R. Malkin, B. F. Drakenfeld & Co., New York, N.Y.
W. A. Morton, Amsler-Morton Co., Pittsburgh, Pa.
F. A. King, Vitrolite Co., Parkersburgh, W. Va.
R. F. Brenner, Vitrolite Co., Parkersburg, W. Va.
S. R. Scholes, Federal Glass Co., Columbus, Ohio.
P. C. Laux, Columbus, Ohio.
E. G. Klotz, Ohio Hydrate & Supply Co., Woodville, Ohio.
H. L. Cupples, Ohio State University, Columbus, Ohio.
G. H. Vanderborgh, Ohio State University, Columbus, Ohio.
F. D. Morrison, Columbus, Ohio.
D. J. McSwiney, Consulting Chemist, Columbus, Ohio.
Ray S. Godard, Consumers Glass Co., Montreal, Canada.
L. M. Moss, General Electric Co., Harrison, N. J.
W. M. Trimble, Student, O. S. U., Columbus, Ohio.
J. Fletcher Gillinder, Gillinder Brothers Inc., Port Jervis, N. Y.
M. T. Metz, Student, O. S. U., Columbus, Ohio.
N. E. Begnon, Student, O. S. U., Columbus, Ohio.
G. E. Barton, Whitall-Tatum Co., Millville, N. J.
A. N. Finn, Bureau of Standards, Washington, D. C.
J. K. Masthead, Monongah Glass Co., Fairmont, W. Va.
L. R. Milford, Solvay Process Co., Syracuse, N. Y.
Elmo P. Arthur, Pittsburgh Sheet Glass Co., Washington, Pa.
Fred S. Thompson, National Lamp Works, Cleveland, O.
J. F. McClain, Harrison Bulb Works, G. E. Co., Harrison, N. J.
Chas. D. Spencer, Nat'l Lamp Works, G. E. Co. Cleveland, Ohio.
J. C. Hostetter, R. I. Div. Corning Glass Works, Central Falls, R. I.
G. V. McCauley, Corning Glass Works, Corning, N. Y.
J. T. Littleton, Jr., Corning Glass Works, Corning, N. Y.
N. A. Yung, Consulting Engineer, Pittsburgh, Pa.
R. W. Rotherock, Student, O. S. U., Columbus, Ohio.
E. M. Waxbaum, Student, O. S. U., Columbus, Ohio.
B. B. Annis, Student, O. S. U., Columbus, Ohio.
B. S. Phillips, Student, O. S. U., Columbus, Ohio.
A. E. Williams, Thatcher Mfg. Co., Elmira, N. Y.
George Blumenthal, Jr., Ceramic Industry, Chicago, Ill.
C. O. Fairchild, Bureau of Standards, Washington, D. C.
Alexander Silverman, University of Pittsburgh, Pittsburgh, Pa.
W. L. Brownlee, Buckeye Clay Pot Co., Toledo, Ohio.
W. L. Orme, Cambridge Glass Co., Cambridge, Ohio.
R. R. Shively, B. F. Drakenfeld & Co., Washington, Pa.
J. C. Kelly, Cambridge Glass Co., Cambridge, Ohio.
W. F. Curtis, Fostoria Glass Co., Moundsville, W. Va.
F. B. Garrod, Owens Bottle Co., Toledo, Ohio.
H. Hellmers, Akro Agate Co., Clarksburg, W. Va.
L. J. Franz, Student, O. S. U., Columbus, Ohio.
A. Ernest MacGee, U. S. Bureau of Mines, Pittsburgh, Pa.
George Aurien, Mississippi Glass Co., St. Louis, Mo.

Buying Coal on Specifications

By J. B. Krak, Technical Editor

Generally speaking there are two methods of purchasing coal. One is by relying on the character and reputation of the seller. A second way is by specification, based principally on the determination of the heating value and chemical analysis.

The first method is in quite general use today. This is rather a surprising fact. In many industries, coal is one of the principal items of expense. In the glass industry fuel is, of course, by far the greatest expense and yet less attention is paid to its quality than to any other factor entering into the cost of the finished product.

No executive would for a moment consider depending solely on the high character and reputation of an engineering concern that is to construct a manufacturing plant for his corporation. To be sure these qualities will be demanded as a first requisite. But specifications of every description will be required for every part of the building and equipment, no matter how excellent the rating of the contractor. What is more, great care will be exercised to see to it that every clause of the contract is faithfully carried out.

It does not require much calculation to prove that over a number of years the fuel bill of a glass factory far exceeds the cost of plant and equipment. This being the case, it follows that the matter of purchasing fuel on a specification basis is well worth considering. This applies to gaseous and liquid as well as to solid fuel. The latter, however, is more apt to vary widely in composition and the matter of specification is of greater importance with reference to coal than to gas or oil.

Buying coal on a specification basis has been practised by

a number of large consumers since about 1902. The Interborough Rapid Transit Company of New York may be mentioned as one of the first concerns that has contracted for all of its coal on a specification basis. The United States Government, probably the largest single purchaser of coal, buys its supplies strictly on elaborate specifications. At the beginning of the war the tendency to buy coal on specification was growing, notwithstanding the increasing opposition on the part of coal operators and dealers.

The war boom of 1916 followed by the post-war inflation of 1919 gave the coal interests practically a free hand. Among the expressions with which the war period has enriched the vernacular "fire-proof coal" will long be remembered. The coal strikes tended to further strengthen the position of the coal interests. Present conditions are such that in many cases specifications have been relaxed or entirely abandoned.

It must be conceded that opposition against specifications is not entirely groundless. At times they have been drawn in such a manner as to be distinctly unfair to the seller; especially city and state institutions have been known to exact terms which were impossible to fulfill.

It is a difficult matter to obtain a truly representative sample of a large shipment of coal. Due consideration must be given to the number and location of points from which different portions of the sample are collected. Next in importance is the manner in which crushing, quartering and pulverizing the sample has been carried out. Once a fair sample is obtained the analysis is the simplest part of the procedure and by far the most accurate.

For most purposes a proximate analysis and knowledge of the B.T.U. value is all that is required to form an opinion as to the value of a coal for use in a gas producer or under a boiler. There is a growing demand for knowledge concerning the fusion point of the ash. The importance of this feature will be appreciated by anyone who has had to deal with the clinker and slag caused by low refractory coal ash, either under a boiler or in a gas producer. However the procedure to determine the fusion point of coal ash is as yet not standardized and is quite difficult to carry out.

The proximate analysis of coal is among the simplest operations an analyst may be called upon to perform. It does not require expensive apparatus. The determination of moisture and ash can be carried out in a small porcelain dish. Volatile matter can be determined by using a nickel crucible, which can also be used for the estimation of sulphur by Eschka's method.

The determination of the fuel value requires the use of a calorimeter. This is rather a costly apparatus and several attempts have been made to obtain a formula by means of which the B.T.U. value can be calculated from the results of the proximate analysis. None of the formulas proposed are applicable to all varieties of coal. When coal is derived from one and the same vein, variations in the amount of ash are a fairly sure guide as to changes in the fuel value. But when the product is obtained from various mines and from different coal beds the ash figure cannot be considered as a basis of comparison. This is due to the fact that the actual "coal substance" is not chemically uniform but consists of varying ingredients having different fuel values.

A formula which possibly has a wider application than any other has been proposed by Goutal.[1] This formula is based on determinations of the calorific value of 600 different samples of coal and yields values which agree with those obtained with the bomb calorimeter sufficiently close for technical purposes.

Goutal's formula:

Calorific value in calories $= 82\ C + a\ V$, in which:

C is percentage of fixed carbon,

V is percentage of volatile matter,

a is a constant depending upon the percentage of volatile matter calculated on the ash and moisture free basis.

$$a = \frac{100 \times V}{C + V}$$

The following table contains the value for corresponding values of $\frac{100 \times V}{C + V}$

$\frac{C+V}{100 \times V}$	a	$\frac{C+V}{100 \times V}$	a	$\frac{C+V}{100 \times V}$	a
1–4 incl.	100	16	115	29	99
		17	113	30	98
5	145	18	112	31	97
6	142	19	110	32	97
7	139	20	109	33	96
8	136	21	108	34	95
9	133	22	107	35	94
10	130	23	105	36	91
11	127	24	104	37	88
12	124	25	103	38	85
13	122	26	102	39	82
14	120	27	101	40	80
15	117	28	100		

Example of the application of Goutal's formula:

Analysis[2]	Per cent
Moisture	0.80
Volatile matter	35.70
Fixed carbon	57.27
Ash	6.23
Fuel value (calorimeter)	14,110 B. T. U.

$\frac{100 \times V}{C + V} = 38$; a = 85 (See table).

Fuel value in calories: $82 \times 57.27 + 85 \times 35.70 = 7730$ cals. $= 13.914$ B. T. U.

What Coal Specifications Should Cover

The object of coal specifications is to make certain that the purchaser shall obtain the quality of coal desired at a fair price during the life of the contract.

To insure this there should be specified:

1. The period of time covered by the contract.
2. The kind of coal and amount needed.
3. The method of delivery.
4. A standard analysis as a basis of computation.
5. The standard price.
6. The scale of penalties or premiums based on actual losses due to inferior coal, or of greater efficiency derived from higher grade fuel.
7. The method of sampling to be used.
8. The quantity of coal which each sample is to represent.
9. The chemist who is to make the analysis.
10. The method of obtaining the final price.

[1] Comptes rendus, 135, 12, 477-79.
[2] Sample of Redstone Coal, Morgantown, West Virginia.

The Use of Garnet for Glass Grinding

A more extended use of this abrasive is expected to follow the establishment of a regular, dependable source of supply.

The great development which is being observed in the plate glass industry has been due in part to the insistent demand for more glass of better quality. This demand has been especially heavy on the part of the automotive industry. Every detail of the processes of plate glass manufacturing is being investigated to find ways to improve existing methods.

Garnet, used for many years as an abrasive, especially for the production of sand paper, is now being applied as a medium for glass grinding. As is well known, in the manufacture of plate glass it is necessary to grind the surface of the newly cast and rolled sheet beneath iron-shod rollers. A mixture of sand and water is applied between the iron of the rollers and the glass surface until it has been ground to a plane. W. M. Myers, Associate Mineral Technologist, Bureau of Mines,, who has made an investigation of the uses of garnet, states that garnet can be employed for the "fining" process which follows the coarse grinding. In order to be effective the garnet must be ground very fine. It is used in the same manner as sand in the first coarse grinding. After grinding with garnet the glass is ready for polishing with felt rollers and rouge. Other abrasives than garnet are also used, particularly fine sand, emery, corundum, alundum and aloxite.

The production of garnet increased from 1922 to 1923 from 7,054 short tons, having a value of $566,879 to 9,006 short tons valued at $688,437. Of this output only a small part is being used in the plate glass industry. It was first employed in 1914 and its use has gradually increased since that date. Garnet is used by several plate glass manufacturers including the Ford Motor Company.

The advantage of garnet lies in its great hardness. In the scale of hardness it is placed at 7½ while quartz is 7.

The resistance of a smooth plane surface to abrasion is called its hardness, and is usually recorded in terms of a scale of ten common minerals:

1. Talc
2. Gypsum
3. Calcite
4. Fluorite
5. Apatite
6. Orthoclase
7. Quartz
8. Topaz
9. Sapphire
10. Diamond

Although softer than corundum garnet possesses the advantage of having a splintery fracture, which prevents it from wearing smooth.

The garnet group includes several mineral species which are essentially silicates of alumina with iron and lime, magnesia, manganese and chromium.

The two commonest species are Almandite, $Fe_3Al_2(SiO_4)_3$ and Grossularite, $Ca_3Al_2(SiO_4)_3$.

The garnet industry is an important one in the Adirondack region of New York, a steady production coming from Essex and Warren counties.

T. S. Mennie, manager of mines, Barton Mines Corporation, North Creek, N. Y., has contributed the following article which will be of interest to users and prospective users of glass grinding abrasives, especially in the plate glass industry.

Mining and Milling of Garnet for Grinding Glass

On Gore Mountain, about four and a half miles, as the crow flies, southwest of the village of North Creek, Warren County, New York, are the "Barton Mines." Here is the largest known deposit of garnet in the world. This property is owned by H. H. Barton & Son Co. of Philadelphia, and is being worked under lease by Barton Mines Corporation.

North Creek is the terminus of the branch of the Delaware & Hudson Railroad, which runs into the summer resort section of the Adirondack Mountains from Saratoga Springs, N. Y. The mines are reached by five miles of macadam road to the village of North River, and five and a half miles of dirt road up the slope of Gore Mountain. It is the intention of the company to build a new road down the east slope of the mountain to a point on the North Creek-Sodom road, known as "French Settlements," which will place the mines within four and a half miles of North Creek by road. The altitude at the mines is 2,800 feet, and by the present road there is a rise of 1,800 feet in about three miles.

PURE GARNET POCKETS

The deposit is of large dimensions. It has been opened by three quarries for a width of approximately one hundred and fifty feet without finding either wall and for a total length of approximately two thousand feet, while the outcroppings can be traced for another three thousand feet. The depth from the top of the breast in No. 1 quarry to the floor in No. 3 quarry is approximately eighty feet, but no attempt has been made to find the bottom, the three quarries being as three benches on the side of the mountain.

The garnet is of the iron-alumina Almandite variety, occurring as nodules in a dark gray, massive granular, porphyritic rock, which consists largely of hornblende and feldspar inclosed in gneiss. The garnet nodules are single individual crystals of imperfect form, varying from 2 inches to 3 feet in diameter, surrounded by shells of hornblende.

The garnets are laminated or divided into thin plates by a system of parallel parting planes and occur roughly bunched in pockets. Almandite garnet is one of the two types of garnet that are valuable for abrasive purposes, especially for the manufacture of garnet sand paper and cloth, and for grinding in the plate glass industry; and the district tributary to North Creek is the total source of Adirondack Almandite garnet, conceded to be the best abrasive garnet in the world.

This deposit has been worked for the past forty years by open quarry methods and hand cobbing, producing approximately 900 tons of commercial garnet per year. With the present equipment it can be made to produce 8,000 tons per year or more. There is now in operation on the property a

GARNET MILL AT BARTON MINES, NORTH CREEK, N. Y.

wet concentrator with a capacity of 250 tons of ore per day. This mill was designed by the James Ore Concentrator Co., of Newark, N. J., and was completed in March 1924.

In the quarries the ore is drilled with jack hammers, using air at 80 lbs. pressure, and after being blasted down is loaded with steam shovels into Koppel side dump cars and hauled to the mill by gasoline locomotives. There is also a large quantity of rich ore on the dumps which is the refuse of hand cobbing and which will be put through the mill.

At the mill, the ore is dumped into a receiving pocket in front of the first crusher, the ore passing direct to a 24 inches by 36 inches Traylor bulldog jaw crusher set to crush to 3½ inches. From this crusher the ore falls onto a feeder and is fed to a continuous bucket elevator discharging into a trommel screen with ¾ inch round holes. The undersize from this screen passes direct to a 500 ton storage bin, the oversize to a slow moving picking belt, where the clean garnet, or "high grade," can be picked out and where the tramp steel is caught by a magnetic head pulley. The ore passes through a No. 3 Telsmith gyratory reduction crusher and into the same elevator with the ore from the first crusher, making a closed circuit with the screen as the outlet. Thus all the ore in the bin is minus ¾ inch.

From the 500 ton storage bin the ore is fed to the separating side of the mill by a conveyor converted into a feeder by the use of a ratchet and pawl. The ore is then elevated to a series of five trommel screens, the coarsest one of which has one-half inch round holes. The oversize of this trommel is sent to a set of Traylor rolls set about ⅜ inch apart where it is cracked and returned to the feed. The other four trommels separate the ore into four oversizes and one undersize. The four oversizes are treated on eight James three-compartment automatic diaphragm jigs 24 inches by 36 inches, where the garnet is separated from the gangue and automatically discharged, a middling is returned to the feed, and a tailing is sent to the waste. The undersize from the last trommel, being all of the fines, is given a combination treatment by four James sand roughing tables, and four James sand finishing tables, and four James single compartment automatic diaphragm jigs 18 inches by 24 inches. This combination treatment is new in the art of concentration, the result of necessity, and was worked out by the writer at a mill in this district following a suggestion by U. S. James after all other known wet concentration practice had failed to produce a concentrate of marketable grade from this fine material, due to the close specific gravity.

It consists of putting the total feed over roughing tables, making a tailing waste, a middling, and a rough or dirty concentrate. This concentrate is cleaned on the diaphragm jigs with a very fine screen, a bedding of bird shot, and a stroke of only 3/16 inch. The jigs discharge a concentrate of about 90 per cent garnet and a tailing which is sent along with the roughing table middling to the finishing tables. These tables make a tailing waste, a middling which returns in their own feed, and a dirty concentrate which goes to the diaphragm jigs making a closed circuit with the jigs and finishing tables. Thus the tables make all the tailing waste and the jigs make all the concentrates.

All the tailing from the mill is elevated to the top floor to a duplex Dorr classifier where it is dewatered, the tailing passing out of the building to the tailing dump. All the concentrates are elevated to the same floor to a simplex Dorr classifier for dewatering. The overflow from both classifiers is sent to a Dorr thickener, 40 feet diameter, 10 foot stave, where the water is reclaimed and used over in endless circuit. The settled sludge is pumped out of the thickener by a Dorr diaphragm belt-driven pump at a consistency of one to one. The garnet concentrate is passed from the classifier to a 6 foot by 30 foot Lowden dryer in the basement, where it is dried and bagged in 100 pound bags for shipment. The Lowden drier is fired with oil fuel.

The mill is driven by two De LaVergne oil engines of the vertical solid injection type of 130 horsepower each and using fuel oil.

For fuel oil supply there is provided a 10,000 gallon storage tank at the mill and a 12,000 gallon tank at the railroad at North Creek. Oil and other supplies are hauled to the mines and concentrate hauled to the railroad with two Linn caterpillar tractors with trailers.

The company is now erecting a mill to grind garnet minus 200 mesh to supply the glass trade with this abrasive for plate glass.

The company's land is heavily timbered, they have their own saw mill on the property, a first class up-to-date boarding house, the dining room of which will seat 150 people; sleeping camps, office, barns, store houses and cottages, for employees. The winters are mild, the summers warm, the scenery grand, the climate healthy, and the forest abounds with game.

The Decolorization of Glass

By D. J. McSwiney*

(Concluded from the February Issue)

Up to ten years ago the only decolorizer used to any considerable extent for the production of colorless soda lime glass was manganese. It is almost invariably added to the glass batch in some form of manganese dioxide—usually as the mineral pyrolusite, although sometimes the manganese dioxide recovered from the manufacture of chlorine is used. The latter is very much purer than the former, is usually free from iron, is of constant composition, and is much more finely powdered so that it can be uniformly mixed with the batch; it is also much higher in price. Pyrolusite varies widely in composition, not only from different sources, but even from the same source, so that considerable variation may be met with not only in different lots of the mineral, but even in different portions of the same lot. The decolorizing value of the material varies with its composition, and if allowance is not made for this variation, the color of the ware varies. Even the best grades of pyrolusite seldom contain much more than eighty per cent active manganese dioxide and some grades contain as low as forty per cent. Some grades contain considerable iron, and these should be avoided as decolorizers. Pyrolusite is ordinarily used in a coarsely powdered condition; this, however, does not appear to greatly affect its coloring power.

MANGANESE vs. SELENIUM

Manganese gives best results when used in closed pots, under careful control. In tanks selenium is superior since manganese is sensitive to flame conditions and hard to control.

Action of Manganese

Manganese gives to soda lime glass a purple coloration—i. e., a combination of red and violet with blue. The exact cause of the coloration due to manganese is not definitely known; it is probable, however, that the coloration is due to the formation of a highly oxidized manganese compound similar to the permanganates, all of which are highly colored and the color of which closely resembles that given by manganese to glass. The development of the manganese color depends on the maintenance of oxidizing conditions during the melting of the glass; if oxidizing conditions do not prevail during the melting the manganese compounds do not give a coloration but dissolve in the glass in a colorless form. Strongly oxidizing conditions are brought about by adding to the batch a strong oxidizing agent. Manganese dioxide itself is an oxidizing agent being more highly oxidized—that is, containing more oxygen—than the normal manganese compounds. But it is probably less highly oxidized—that is, contains less oxygen—than the manganese compound which gives the color to glass. It can serve for the production of this compound by the oxidation of part of the manganese dioxide to form the color compound at the expense of the remainder of the manganese dioxide—that part of the dioxide serving as an oxidizing agent being reduced to the colorless normal manganese condition. In practice the oxidizing condition is produced to a large extent by the addition to the batch of nitre; more than thirty-five per cent of the weight of nitre consists of oxygen which is available as an oxidizing agent. Only a small portion of this oxygen is, however, actually effective in the glass, owing to the fact that the nitre decomposes very rapidly at glass melting temperatures in the presence of silica and during the decomposition all the oxygen is set free during the first stage of the melt. However, part of the oxygen evolved is used to free the glass and batch materials from any reducing agent such as pieces of paper, wood, etc., which might prevent the formation of the manganese color or which might reduce and decolorize it, once it has formed. Part is used to change some of the iron from the ferrous to the ferric condition and part remains dissolved in the glass. The decomposition of the nitre also helps prevent the early decomposition of part of the manganese dioxide. It is probable that the color formation takes place largely through the medium of the oxygen from the nitre, which is dissolved in the glass, and that this dissolved oxygen is a strong influence in the maintenance of the color, once it has formed. The evolution of oxygen by the nitre helps to clear the atmosphere above the glass from any reducing gases when the glass is melted in a covered pot, but has little permanent influence in this direction in an open pot or tank.

The development of the manganese color, taking place under oxidizing conditions, has considerable influence on the character of the iron color present. By the use of considerable nitre, a large portion of the iron present is changed to the ferric condition. This decreases the depth of color obtained over that which would be obtained with the same amount of iron under neutral or reducing conditions and consequently the decolorization proceeds more smoothly. Moreover, the yellow of the ferric iron is more easily complemented than is the green of the ferrous iron with less loss in transparency of the glass and with less production of off colors when an excess of decolorizer is used. Because of this it is possible to decolorize a glass of greater iron content using manganese than when selenium is used. Also with glasses of the same iron content, the best result obtainable with manganese is better than the best result obtainable with selenium. The best results obtainable with manganese as a decolorizer are attainable commercially only in closed pots and under close control; the average color obtainable with manganese in open pots or in tanks is inferior to that which can be obtained control; the average color obtainable with manganese in open pots or in tanks is inferior to that which can be obtained with selenium under the same conditions. This is because

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the manganese color on which its decolorizing power depends is not only apparently somewhat unstable at high temperatures, so as to slowly burn out, but it is also very sensitive to the action of reducing agents, so that a slightly smoky flame in a tank acting on the glass for only a short time exerts a strong action on the color, reducing part of the highly oxidized manganese coloring compound to a colorless normal manganese compound, and by thus decreasing the manganese color it allows part of the uncomplemented iron color to show.

"Burning Out" of Manganese

As is well known, the manganese color very often burns out to some extent in the lehrs. This decrease in the manganese color at this point is probably due not so much to the temperature of the lehr as to the presence of reducing gases and to the large glass surface exposed. Because of this burning out of the manganese color in the tank and lehrs, the amount of color added to the batch should be such that proofs from the melting end of the tank should show a pink color; the depth of color varying with different batches, batch materials, and operating conditions but being fairly constant with the same materials and operating conditions. In using manganese as a decolorizer the greatest care should always be taken to maintain an oxidizing flame in the tank; this means not only a flame free from smoke but one in which the waste gases show no carbon monoxide indicating incomplete combustion from an insufficient air supply. The raw materials also should be kept free from dirt and organic matter such as wood, oil, coal, etc.

In decolorization with manganese, when much yellow ferric color is present together with only a relatively small amount of green from ferrous iron, if an amount of manganese be used sufficient to take care of the green color there will not be enough blue added to completely complement the yellow color at the same time and the glass will appear a straw color. The remedy is not of course to use more manganese, but to add an additional decolorizer giving only blue, such as cobalt.

The greatest iron content in a glass which it is possible to decolorize by means of manganese is about .18 per cent to .20 per cent iron oxide, and decolorization of this amount is possible only in closed pots and with careful control. The amount of manganese necessary varies widely, depending on the amount of iron present, on the amount of nitre used, on the melting temperature and the length of time the glass is held at that temperature, and especially on the degree of reduction to which it is subjected in the lehrs and during melting. The total amount of manganese added is never converted into decolorizing material, but instead a large portion remains in the glass in a colorless condition.

When glass decolorized by manganese is exposed to sunlight, it gradually develops a purple color. This is probably due to the oxidation of some of the colorless manganese compounds in the glass by the oxygen dissolved in the glass, under the influence of the sunlight.

Manganese vs. Selenium

Manganese as a decolorizer for ordinary glass in tanks is very inferior to selenium, not because it cannot decolorize as well as selenium, for as stated above, it is capable of giving better results than selenium, but because the color being very sensitive to flame conditions is uncertain and difficult to control. In covered pots, manganese is capable of giving at least as good a color as selenium if controlled with reasonable care and is probably to be preferred to selenium for fine tableware or in any case in closed pots where perfect decolorization and high transparency are especially important.

Although the cost of pyrolusite is only a small fraction of the cost of selenium, the cost of manganese as a decolorizer is in most cases greater than that of selenium, for while less than an ounce of selenium per ton of sand is usually necessary, the manganese necessary might amount to fifteen pounds or more. The cost of the manganese batch is also increased by the increased cost of nitre over that of soda ash. It is impossible to specify exactly how much manganese is necessary for a certain amount of iron, as the amount necessary varies greatly with the conditions to which the glass is subjected and with the amount of nitre used.

Effect on Refractories

The action of a manganese batch on the tank differs considerably from that of a selenium batch. The nitre in a manganese batch melts down very rapidly when introduced into the tank, tends to spread over the surface of the glass and to attack the walls, especially in the vicinity of the doghouse, so that the attack on the walls, especially the rear walls, is somewhat greater in a batch containing nitre than in a straight soda ash batch. This corrosive action of the nitre is however limited to the rear wall and the rear half of the side walls, and does not extend well up into the tank as the nitre rapidly combines with the silica of the glass and batch and loses its corrosiveness. In a tank using a bridge-wall, the bridge-wall is by far the weakest point, and the probability is that the tank will go out at that point. In such case, any slight increase in the corrosion of the rear walls has no effect on the life of the tank.

It is well known that tanks in which flint glass is made by decolorization with selenium do not last as long as green tanks melting the same batch without decolorizer under the same conditions, or as long as flint tanks in which manganese is used as the decolorizer. The blame is ordinarily placed on the selenium, but the guilty material is not the selenium but the arsenic that is used in conjunction with it. It is usually supposed that all the arsenic added to the batch is volatilized from the glass during the first stage of the melting, but this is not the case; part of the arsenic is vaporized unchanged, part is used up in oxidizing iron and organic impurities and a large part of what is added combines with soda to form sodium arsenate or arsenite. These compounds are quite stable towards the action of glass at melting temperatures, and their action on the block is similar to that of nitre, but while nitre loses its effect rapidly through reaction with the glass, the arsenic compounds are acted on only very slowly by the glass so that large amounts of these compounds are still in the glass at the time it passes through the throat and thus are able to exert their corrosive action on the weakest part of the tank.

While selenium has been used in this country and abroad

for many years for the production of ruby glass it was only a few years before the war that its use as a decolorizer was first proposed and it was only after the war caused the price and the difficulty of obtaining manganese to greatly increase, that it began to be used in this country for that purpose to any great extent.

As noted above, the color given by selenium is due to the presence of colloidal selenium in the glass. The colloidal state is an unstable condition, and with any substance in this condition there is always a tendency for the minute particles to coalesce and form larger particles. As the particles become larger in size the properties of the substance become more like the properties of the substance in its ordinary condition. This phenomenon is shown by selenium, which in colloidal form in glass shows a pink or orange color, the exact tint depending on the average size of the colloidal selenium particles; but it often shows a brownish cast or a brownish color due to the formation of larger particles through the coalescence of the very small colloidal particles. To prevent the formation of these large brown coloring particles or to eliminate them, once they have been formed, arsenic is used in conjunction with the selenium. The arsenic not only tends to eliminate the brown cast but it also controls to some extent the formation of the color and the tint obtained. The tendency of selenium to give a brown cast depends somewhat on the nature of the batch, on the form in which the selenium is used, on the melting temperature, and especially on the amount of selenium added to the batch. This tendency appears to be increased somewhat by an increase in the alkaline content of the batch, i. e., an increase in the percentage of soda and potash, and to be decreased by increasing the content of alkaline earth, such as lime or barium oxide. An increase in the melting temperature decreases the brown coloration; the tendency to form the brown coloration increases rapidly with an increase in the amount of selenium used above a certain point.

SELENIUM cannot fully decolorize glass containing over .10 per cent iron oxide. For high grade ware glass should not contain more than .07 per cent iron oxide. This would limit glass sand to .07 per cent and limestone to .10 per cent iron oxide.

The use of arsenic to eliminate the brown color of selenium requires the use of a larger amount of selenium for a certain iron content than would be required if no arsenic were used, because the arsenic tends to burn out part of the selenium color or to change it to a colorless condition. This burning out action of arsenic is of value in the case of a glass overcolored by selenium, when the excess color can be readily removed by increasing the amount of arsenic used. As noted above, the use of arsenic causes an increased attack on the tank block and especially on the throat. Selenium can be used without arsenic, but the results are very much more uncertain than when arsenic is used and the glass is usually not clear, but has a brownish cast. The amount of arsenic used, however, is often very much in excess of what is actually necessary.

Nitre used in small amounts has little effect on selenium color, but used in quantities of fifteen pounds or more to the ton it decreases the coloring power of the selenium. Salt cake, used in amounts of ten pounds or more, also decreases the coloring power of the selenium, its action being more prolonged than that of nitre in the absence of strong reducing conditions.

The selenium color forms best in a slightly reducing atmosphere, but it is stable to a mildly oxidizing atmosphere. It tends to burn out very slowly in the tank but there is often a tendency for the color to develop somewhat in the lehr. Because of this, a proof from the melting end of a tank should show a very light pink color, very much lighter than is the case with manganese, in order that the glass will be colorless at the machines. The color development in the lehrs sometimes takes place unevenly if the heat distribution in the lehr is not uniform, so that large ware will sometimes be seen in which the center will be colorless, the top or bottom high in color and the other end slightly low in color. This, of course, affects the market value and at times may cause serious losses.

Forms of Selenium Used

Selenium is added to the batch as black elementary selenium, as sodium selenite and as barium selenite. When added as black selenium, part of it is lost through volatilization when the batch is filled in, but the amount lost in this way is very much less than is usually supposed. Because of this loss by volatilization, somewhat less actual selenium is necessary when added as a selenite than when added as free selenium. The selenium of commerce is usually more than 97 per cent pure, but at times may contain only as little as 85 per cent, the impurities being for the most part silica and moisture. The amount of selenium required for decolorization varies from ¼ oz. to 1½ oz. per ton of sand.

Sodium selenite contains from 38 per cent to 45 per cent selenium; from two to two and three-quarters times as much sodium selenite as selenium is required for decolorization. Barium selenite contains about 29 per cent selenium, so that about three times as much is necessary as is necessary of free selenium. Sodium and barium selenites, especially the latter, do not appear to have as great a tendency to give a brown cast as free selenium does. Barium selenite is to be preferred to the sodium salt as it is usually purer and is more easily handled. The commercial sodium salt readily absorbs water and lumps up. As very little selenium is required in each lot of batch weighed out, it is advisable, especially if free selenium be used, that the selenium or the selenium compound be first diluted by mixing thoroughly with some other of the batch materials so as to make accurate weighing easier. For this purpose the arsenic to be used is probably to be preferred for with the other batch materials the fine particles of selenium are more apt to settle to the bottom on standing under vibration.

All the selenium added to the batch does not aid in the decolorization, a small portion being volatilized and a part

of that left in the glass being retained there in a colorless form; the amount of the latter is, however, very much less than is the case with manganese. Selenium is not affected by lead present in the amount of one to two per cent if arsenic is used in the batch, but it cannot be used for high lead batches owing to the formation of black lead selenide.

As selenium ordinarily gives an orange color and its color is free from blue, it is as a rule necessary to use a small amount of cobalt in conjunction with it. The amount of cobalt needed is usually between 1/10 and 1/5 of an ounce.

As explained above, the limit of decolorization by means of selenium is lower than that with manganese. Under commercial conditions, it is not possible to decolorize glass containing more than .10 per cent iron oxide by using selenium, and glasses of that iron content when decolorized have low transparency and appear dull and dirty. In order that the finished ware shall have a good clear color, under ordinary commercial working conditions, the glass should not contain more than .07 per cent iron oxide. To this effect, the limit of iron for a good glass sand should be about .07 per cent, for a limestone about .10 per cent iron oxide and for a high magnesia lime about .20 per cent. These figures refer to the iron content as determined colorimetrically by the use of the sulphocyanide method; the apparent iron content varying somewhat according to the way it is determined. If attempt is made to decolorize amounts of iron greater than this, the result is usually a dirty brownish or blackish glass. The quality of the decolorized glass and the ease of decolorization increases with decreasing iron content of the raw materials; with materials of the quality ordinarily used in this country, i. e., sand of less than .06 per cent and limestone of less than .08 per cent iron oxide, little difficulty should be experienced in obtaining a good clear flint glass by the use of selenium if the raw materials run uniform in iron content or if the amount of decolorizer used be varied to take care of variations in iron content. As noted above, the great advantage of selenium over manganese as a decolorizer in tanks lies in the far greater stability of the selenium color to temperature and flame conditions; in this respect its advantage is so great that the use of manganese in tanks should be considered only in those cases where the batch requires the use of large amounts of oxidizing agents, where the amount of iron in the raw materials is excessive, or in high lead glasses. In closed pots, when the iron content of the raw materials is very low, selenium can give a color as good as that given by manganese, but as the iron content increases the color given by manganese under reasonably careful control improves over that obtainable with selenium.

Glass decolorized by selenium is usually less rapidly affected by sunlight than that decolorized by manganese; the color produced in the case of selenium glass is yellowish, sometimes with a brownish cast.

Cobalt in some form is the material ordinarily used to supply any blue color needed for decolorization. It is usually added either as cobalt oxide or in the form of a powdered blue glass containing four to six per cent cobalt. It is seldom used alone, but usually in conjunction with manganese or selenium. Most prepared selenium decolorizers contain some cobalt. Cobalt is an ideal decolorizing material; it has great coloring power, it gives a color which is very constant and which does not burn out even at very high temperatures.

Tabular Comparison of Decolorizing Agents

	Nickel Compounds	Selenium Compounds	Manganese Compounds	Cobalt Compounds
Relative coloring power.	3	1 highest	4 lowest	2
Relative price per unit of glass.	1 lowest	2	3 highest	
Generally used in form of.	Nickel oxide or sulphate.	Black selenium, sodium or barium selenite.	Manganese dioxide, i.e. pyrolusite.	Cobalt oxide.
Usual color given to soda-lime glass.	Brownish purple.	Orange or pink.	Purple.	Blue.
Stability of color:				
1. At high temperatures.	Very good.	Good, burns out very slowly.	Fairly good, burns out slowly.	Very good.
2. At lehr temperatures.	Very good.	Good, sometimes develops slightly.	Burns out somewhat.	Very good.
3. To flame conditions.	Good.	Good.	Very sensitive.	Very good.
4. To sunlight.	Very good.	Good, sometimes slowly develops yellow.	Often gradually develops purple color.	Very good.
Furnace and batch condition best for color development.	Slightly oxidizing.	Slightly reducing.	Must be oxidizing, preferably strongly.	
Effect on color of variation in batch composition.	Marked.	Slight.	Slight.	Slight.
Used in conjunction with.		Arsenic to eliminate brown cast, also cobalt.	Nitre to effect oxidizing conditions, and cobalt.	
Type of glass best suited for.	Potash glasses.	Tank glass.	Covered pots.	Used to supply blue.
Maximum per cent iron oxide it will decolorize.		.10%	.18%	

Color Due to Titanium

Decolorization is considered strictly a question of the iron contamination of the raw materials as with one exception it is very rare that sand or limestone sufficiently free from iron to be considered as raw materials for flint

glass will contain other coloring materials in amounts large enough to give a decided color to the glass. That one exception is titanium which is found to an appreciable extent in some sands. The color given by titanium to glass varies considerably, depending on the oxidation or reducing conditions present; the color given under ordinary conditions is brownish. This brownish color or cast can usually be removed for the most part by the use of arsenic or nitre.

Summary

Iron usually exists in the glass in two conditions, depending on different states of oxidation. That in the higher state of oxidation gives a color which is of lower intensity and more easily decolorized than that given by the lower state of oxidation; accordingly it is well to use materials containing most of the iron in the higher oxidized state and to maintain oxidizing conditions during the melting in so far as the oxidizing conditions do not interfere with the action of the decolorizer.

Decolorized glass is never as clear and transparent as undecolorized glass of the same or lower iron content owing to the absorption of light in the decolorizing process.

Manganese is capable of decolorizing more iron than selenium under carefully controlled conditions. It is far inferior to selenium for commercial glass in tanks, owing to the sensitivity of the manganese color to flame conditions. In covered pots manganese is capable of giving better results than selenium if controlled with reasonable care.

It is not possible to successfully decolorize glass containing more than a certain amount of iron, which amount depends on the decolorizer used and the form in which the iron is present. With greater amounts of iron the result is a dirty greyish, brownish or blackish glass.

The limits of iron content of raw materials for high grade flint glass in tanks should be not more than .07 per cent iron oxide for sand, .10 per cent for limestone and .20 per cent for magnesia lime.

Standards (C 49-22T) for quick and hydrated lime for the manufacture of silica brick were adopted as a result of a letter ballot by members canvassed several months ago by the American Society for Testing Materials.

Recovery of Silver from Broken Mirror Glass

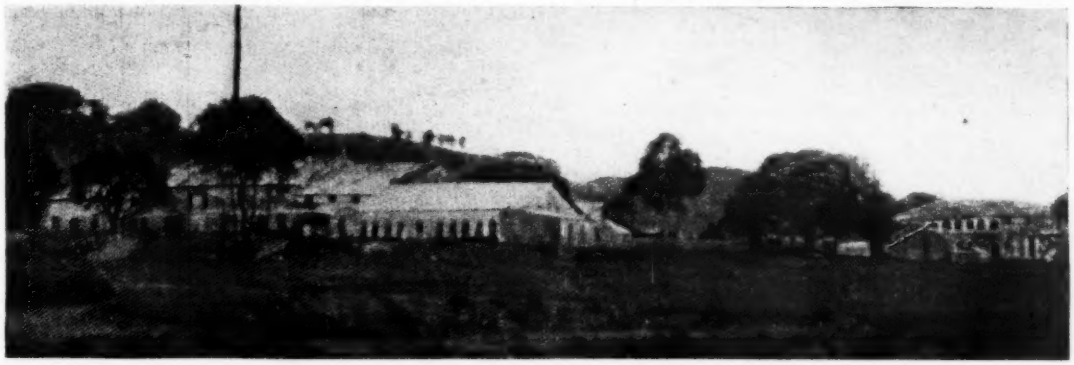
A new procedure to recover silver from bits of broken mirror glass has recently been patented by Dr. Alfred Sternberg of Berlin (German Patent No. 391,131). Silver from broken glass mirrors is usually not recovered in mirror works. The quantity of silver present–about 2 grams per square meter–is too small to make recovery by the usual nitric acid method a paying proposition. Too much water is required to wash out the silver solution retained on the glass surface which results in a very dilute liquor from which it is difficult to recover the silver.

The new procedure is based first on mechanical separation of the silver from the glass, and second, on its subsequent solution by means of acid in the gaseous form.

The observation was made that acids or salt solutions, especially solutions of sodium acid sulphate ($NaHSO_4$) cause the separation of the thin layer of silver from the glass. The glass can either be allowed to soak for a few hours in a solution of sodium acid sulphate or the salt solution is at once poured off and the broken glass is allowed to dry at 120° C. If the glass is then stirred up with water, the silver particles are easily loosened and can be separated by pouring the water through a filter. A current of air is led to the bottom of the container which carries the metal particles to the surface.

If mirror glass is treated with sodium acid sulphate solution at a temperature of 180° C. or more, the silver dissolves easily to form silver sulphate. This method is seldom used.

The recovery of silver is done usually in the form of silver nitrate. It has been observed that if gaseous nitric acid is used, only slightly more than the theoretically needed quantity of acid is required. The easiest procedure is to transfer the mirror glass to earthenware pots, having a perforated shelf resting on the bottom. Under this shelf the calculated amount of nitric acid is poured. It is then diluted considerably. The vessel is kept in a space heated to 120-130° C. Under these conditions the acid is concentrated slowly, while water vapor escapes. During the subsequent evaporation of the nitric acid the reaction is finished by the formation of silver nitrate.



The Jewel Glass Factory at Jubbulpore, Central Provinces, India

This plant, recently purchased by Ganesh Damodar Kelkar, a graduate of the School of Glass Technology, University of Sheffield, England, was put in operation in January under the management of the proprietor. Flower vases, tumblers, Dietz globes, lamp ware, glass roofing tiles, bangles, etc., will be manufactured.

The Glass Industry

ESTABLISHED 1920

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ADVERTISING RATES SENT ON REQUEST

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Specialization in Industrial Journalism

The French like to refer to Marcelin Berthelot, the brilliant scientist whose remains rest in the Pantheon of Paris as the last of the chemists. To one of his friends the master is related to have said while in a reflective mood:

"I believe that I am the last living chemist who can claim to know the whole of chemistry, because I was born at a time when it did not amount to much. I have been able to learn it as I went through life. From now on scientists will have to devote themselves to a specialty if they wish to succeed. Look, just to read the reviews on chemistry appearing each week a twenty-four hour day would not suffice."

And with a gesture of discouragement the great scientist pointed to a pile of publications, German, French, English, American, which lay unopened on his desk.

What applied to chemistry only a few decades ago applies to a vastly greater degree to technology of to-day. Specialization and more specialization has been the means through which the remarkable progress evident in many lines of industry has been attained.

The voice of technology, industrial journalism, has been forced to follow suit. Journals devoted to important divisions of industry have found themselves face to face with the necessity to appoint specialists on their editorial staffs to cover narrowly defined fields. To fill the demand for specialized knowledge, separate journals have been founded that alone are able to adequately survey the length and breadth of the land.

To be able to record and interpret all that happens from day to day in the way of scientific and technical development, to translate into concrete statement the results of research, requires the energy of a specialist. This does not mean that he knows more than all others in his line. But to be successful he needs the insight to recognize where information is available, have the ability to absorb it and present it in readable form.

Some of the newer industries are as yet confined to a few countries. But fundamental industries, those on which the human race has depended since the beginning of civilization, have the world for their scope. They can truly be called world industries and their progress is the outcome of the genius of all lands where men depend on them for their livelihood. A journal devoted to a world industry must needs cover all of the principal countries where the industry flourishes. It must collect and abstract the technical literature in whatever language it may be written. Such a journal, valuable to its readers at home, also has an appeal beyond the boundaries of its own land.

It goes without saying that a specialized industrial journal must be readable and to this end it must appeal to the eye as well as to the mind. Good paper, carefully chosen typography, illustrations, all aid to give to its pages those features which the American public takes for granted but which become apparent only on comparison with the foreign press. However, there should be no place for yellow journalism in an industrial paper. Dignity should never be sacrificed for the sake of attracting the casual reader. The man who is looking for real information is quick to discern

the difference between knowledge and generalities, between enlightenment and diversion.

To the special journal which truly knows its field, which covers it fully and does not include what is beyond its sphere, which keeps resolutely abreast of progress—to such a journal industry does not fail to award its respect and confidence.

Technical Consultation Service

QUESTION 66. METHODS EMPLOYED IN MAKING RUBY GLASS. Please give us some information on the present method employed in producing ruby glass such as is used in automobile tail and other signal lights. An appreciable amount of zinc has been found in some of the glasses analyzed. It is not certain that cadmium is present—it appears to be, but the amount is almost infinitesimal—perhaps as an impurity in the zinc. We will appreciate any information or references you can give us on these points.

ANSWER: With regard to your inquiry as to the present method employed in producing ruby glass for signal lights, etc., this is done by adding selenium to the batch. It is quite possible that glasses used for this purpose contain zinc since this element renders glass more resistant against sudden changes in temperature, having an action somewhat similar to boron. Of course, signal lights have to withstand the sudden change in temperature occurring when, for instance, rain drops strike the glass, heated by the light behind it.

As a rule ruby glass is made from the following ingredients: sand, soda, borax, bone ash, zinc oxide, cadmium sulphide and selenium. The average amount of selenium used is about 12 pounds per 1,000 pounds of sand. Some glass makers use the same weight of cadmium sulphide, others double the amount. Zinc oxide appears to be necessary to produce glass of good ruby color, from 10 to 15 per cent of the weight of sand being used.

Since you mention the analysis of ruby glass in your letter, it has occurred to me that you may be interested in a method of estimating selenium in glass. A convenient procedure is to treat a five gram sample of glass with hydrofluoric and sulphuric acids until the silica has been removed. Nitric acid is then added to effect complete oxidation. The acid is evaporated off and the residue transferred to a beaker. Hydrochloric acid sp. gr. 1.175 is added until a concentration of about 1:1 is obtained and the solution is gassed with sulphur dioxide. The selenium is quantitatively precipitated as red metallic Se which can be filtered in a Gooch crucible, washed with dilute hydrochloric acid, then with water until free from acid and finally with alcohol. It is dried at 105° C. and weighed as Se. The filtrate should be tested for selenium by saturating again with SO_2 gas.

Gold, copper, manganese and iron oxide are used to some extent in the manufacture of red glass. Selenium red, however, is superior for signal lights since it has an intensive red color and yet does not absorb the light rays to any great extent.

The literature on the use of selenium in glass is almost entirely confined to its application in very small quantities as a decolorizer. An interesting article on the chemistry of selenium in glass has appeared in the *Kolloid Zeitschrift*, 1915, Vol. 16-17, pp. 53-58, by Piero Fenaroli.—J. B. K.

QUESTION 67. ETCHING GLASS. Can you advise me as to how I can make etched glass signs? I have been experimenting with hydrofluoric acid and wax, but find I cannot make these signs at a price to sell them as low as other makers. What books on the subject are published?

ANSWER. There is very little printed data available covering the production of etched glass signs. The methods used are primarily based upon the methods you now use. Manufacturers of such glass signs have improved their methods by continuous application.

Many supposedly etched glass signs are nothing more than sand blasted, using stencils made from soft rubber for the purpose.

In acid etching there are two methods available which apparently you have not made use of. The rubber stamp method by which the glass is coated with a heavy black printers' ink which when dry acts as the etching ground medium instead of a wax cover.

The second method is termed the transfer method, the letters or design being printed on rice or sun-bleached tissue paper, heavy black printers' ink being used for the purpose. For regular commercial production the designs are printed from lithograph stones. The tissue paper with the ink design is attached to the glass and allowed to dry. The back of the tissue is then moistened with denatured alcohol and the paper removed leaving the ink impression upon the glass. The design thus produced acts as the etching ground for the design. The regular acid etching can then be done as usual.

Henley's 20th Century Book of Recipes, Formulas and Processes, which can be found in almost any public library gives on pages 325 to 327 considerable data covering the etching of glass. Or you could correspond with the publisher of this work, the Norman W. Henley Publishing Co., 2-6 West 45th street, New York.—C.H.P.

QUESTION 68. DEFINITION OF GLASS. Could you not conveniently let us have at your pleasure and in a brief sentence, a worthwhile definition of the magic word "Glass"?

Realizing it to be no easy task for even the best informed and in view of its too frequent erroneous application in this work-a-day world, we venture to ask your assistance.

Maybe you would be able to refer us, if only as a buttress of your own opinion, to other writers of authority.

We should be grateful for any suggestions, and delighted were we able to quote, and of course with customary credit. The mere word covering as it does so large an area is difficult to define.

ANSWER. We are in receipt of your letter and have given quite a good deal of thought to your request for a definition of the word "glass."

As you state, it is a difficult task to define glass. A definition which would be accurate from a scientific point of view might have no meaning whatever to the millions of people who use glass. We take it that you desire a definition that appeals to the imagination and which at the same time is acceptable to the technologist.

Glass may be defined as "a hard, brittle, transparent or translucent substance, formed by fusing together sand with at least two basic susbstances, usually soda ash and limestone." Or "glass is a substance which has congealed from a molten condition in an amorphous form."

Our own definition is paradoxical but scientifically correct: "Glass is a solid liquid." This contention requires some explanation. It may be recalled that true solids are crystalline, and have a definite crystallization temperature. Glass at a high temperature is a liquid which on cooling congeals without crystallization. It has all of the properties of a liquid, even at ordinary temperature except mobility.

It is realized that possibly none of these definitions are what you desire. However, they are the best we could find at this moment. Can any of our readers supply a definition?—J. B. K.

QUESTION 69. ARSENIC IN GLASS TO ELIMINATE SEEDS. A few months ago I asked you about how to eliminate seeds from window glass. One of the ways that you told me is the introduction of arsenic into the batch. For every 100 pounds of sand, we use 24 of soda ash, 14 of salt cake, 35 of lime and 1 pounds of carbon. The melting end of temperature is around 2,600° F. To this batch, how much arsenic would you add? How do you calculate the amount of arsenic necessary for various amounts of fluxes used? What effects would the arsenic produce on the tank blocks? What precautions should the batch mixer take in handling it?

ANSWER. We would advise you to add from 3 to 5 pounds of arsenic for each 1,000 pounds of sand. The exact quantity to be used depends on the results obtained. If 3 pounds has the desired effect there is no need to add more. Usually a very hot furnace requires more arsenic than one which is operated at a lower temperature.

Arsenic is not without action on the tank blocks, but since the quantity used is small the corrosive power is not a serious matter.

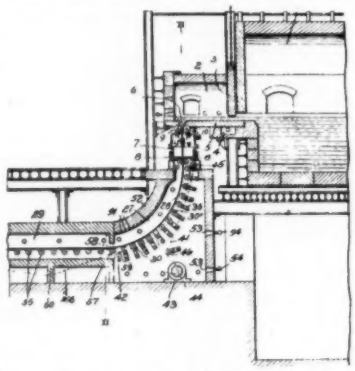
The arsenic should be added and mixed with the batch with the greatest care. Breathing of arsenic dust should especially be avoided. A quantity of 0.06 grams may cause death, so no further comment is necessary.—J.B.K.

Recent Patents

NEW INVENTIONS DESIGNED TO IMPROVE GLASS AND THE MEANS OF PRODUCING IT

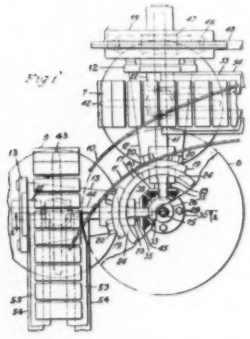
Complete copies of U. S. Patent Specifications may be obtained from the Commissioner of Patents, Washington, D. C. Price 10c each

Process and Apparatus for Making Sheet Glass. 1,519,259. Dec. 16, 1924. Halbert K. Hitchcock, Pittsburgh, Pa., assignor of one-half to Hitchcock Experiment Co. Filed Dec. 12, 1922.



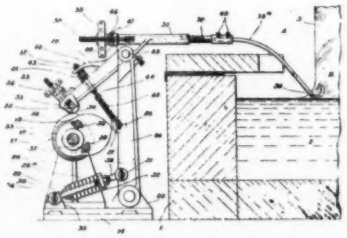
The invention involves the employment of gravity to secure the necessary feeding and stretching action upon the glass sheet, as opposed to the mechanical means for drawing the sheet upwardly as disclosed in a former application, and provides for turning the sheet laterally and feeding it through a horizontal lehr instead of carrying it through a vertical lehr.

APPARATUS FOR HANDLING GLASSWARE. 1,524,641. Jan. 27, 1925. Wilbur S. Mayers, Fairmont, W. Va., assignor to Monongah Glass Co. Filed 10/10/22.



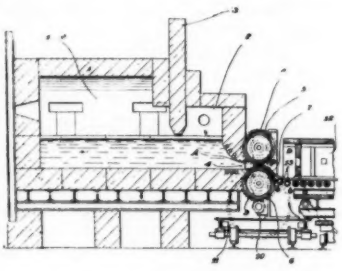
An improved transfer device capable of being adjusted to different heights to correspond to the height of one or more carriers or conveyors with which it is adapted to cooperate in conveying or transferring the ware from one point to another, and improved means for effecting angular adjustment between two or more carriers or conveyors, where it is desired to accommodate them to the positions of the glassware shaping machines from which the ware is transferred by the carriers to lehrs or to other destinations. A rotatably mounted table, a carrier for delivering ware to the table, a second carrier for receiving the ware from the table, one of said carriers being adjustable angularly with respect to the other, means for actuating said carriers and said table, means for guiding the ware to and from the table to transfer it off of one carrier and on to the other and means for adjusting the table vertically to align it with the carriers.

Edge Holding Device for Sheet Glass. 1,519,247. Dec. 16, 1924. John H. Fox and Joseph H. Redshaw, Pittsburgh, Pa., assignor to Pittsburgh Plate Glass Co. Filed Nov. 30, 1923.



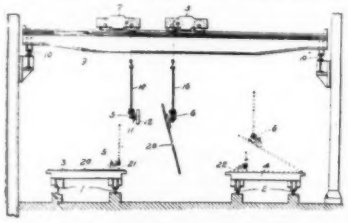
In combination with apparatus for drawing a glass sheet from a molten bath, a lever arm mounted for swinging movement toward and from the sheet in a vertical plane, a second lever mounted on the first lever transversely thereof for swinging movement also in a vertical plane, a pair of fingers spaced apart to straddle the edge of the sheet and carried by said second lever, a cam for swinging each lever, a pair of screw adjustments, including threaded stems and hand wheels carried by the second lever, one for moving the fingers toward and from the sheet, and the other for swinging it about its support on the first lever, and means for rotating the cams.

Apparatus for Making Sheet Glass. 1,519,314. Dec. 16, 1924. Walter G. Koupal, Tarentum, Pa., assignor to Pittsburgh Plate Glass Co. Filed Dec. 5, 1923.



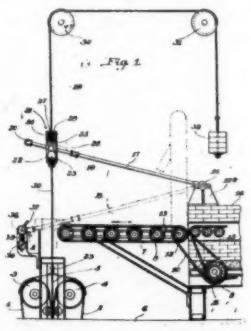
In combination with a tank adapted to carry a bath of molten glass, and having an outlet through one of its walls, and a pair of driven rolls having reduced end portions with shoulders at the juncture of said reduced portions and the body portions of the rolls, hollow metal closure members at each end of the rolls fitting between said reduced portions and abutting said shoulders and closing the triangular spaces at the ends of the body portions on the inlet sides of the rolls, and means for supplying a mixture of gas and air to the interior of said closure members.

PROCESS AND APPARATUS FOR HANDLING GLASS PLATE. 1,519,248. Dec. 16, 1924. John H. Fox, of Pittsburgh, Pa., assignor to Pittsburgh Plate Glass Co. Filed 12/8/23.



Apparatus of the vacuum type for transferring a glass sheet from one car or carrier to another car or carrier and turning it upside down which comprises a pair of vacuum lifting frames supported from above so that they may be given a movement of approach and also moved laterally over the tables, and means for raising and lowering the frames, each frame being pivotally supported so that it may face either downwardly or laterally.

APPARATUS FOR HANDLING GLASS SHEETS. 1,525,124. Feb. 3, 1925. John H. Fox, Pittsburgh, Pa., assignor to Pittsburgh Plate Glass Co. Filed 2/16/24.

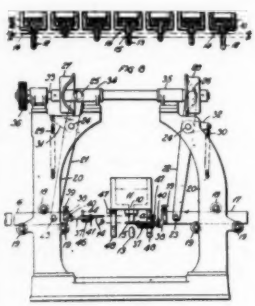


The combination with a vertical sheet glass drawing machine, of a counterbalanced clamping device above the machine adapted to engage the upper edge of the sheet and move upward therewith and give it support during and after the cutting off operation, and a driven carrier extending laterally from a position adjacent the side of the sheet in position to receive the lower edge of the sheet when the clamp is in its upper position, the counterbalance of the clamping device being such that the device will maintain itself in any vertical position in which it is placed when not in engagement with or supporting the glass.

PLATE GLASS TRANSFER APPARATUS. 1,525,147. Feb. 3, 1925. William Owen, Pittsburgh, Pa., assignor to Pittsburgh Plate Glass

Co. Filed 10/31/23. The inventor claims in combination in apparatus for transferring glass sheets from one carrier or car to another carrier or car mounted upon the same track, a fixed framework mounted above the track, a vacuum frame mounted in the framework for rotation and for vertical movement, a crane mounted for movement longitudinally of the track, a second vacuum frame carried by said crane, and means whereby said second vacuum frame may be moved vertically.

APPARATUS FOR OBTAINING CHARGES OF MOLTEN GLASS. 1,525,190. Feb. 3, 1925. William A. Lorenz, Hartford, Conn., assignor by mesne assignments to Hartford-Empire Co. Filed 4/4/22.

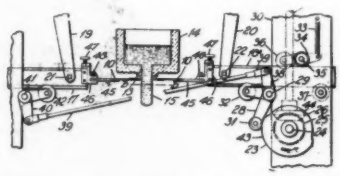


Apparatus for separating molten glass into mold charges of different sizes from glass discharged from the outlet of a container, comprising a plurality of severing means mounted to operate at different levels below the outlet, means for alternately actuating said severing means, and means for adjusting the levels to vary the proportions of the charges.

By suitably varying the size of the charges in a given series or cycle of severing operations, and repeating the series, a plurality of molds or shaping machines for making glassware of different sizes or weights may be regularly and continuously supplied with the required sizes of mold charges and in the required order from a single feeding machine.

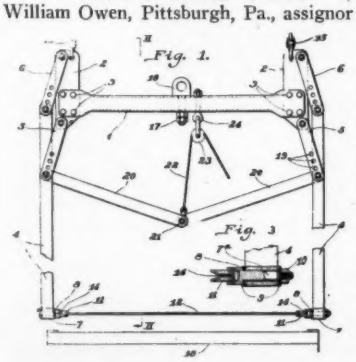
METHOD OF OBTAINING VARYING CHARGES OF MOLTEN GLASS. 1,525,189. Feb. 3, 1925. William A. Lorenz, Hartford, Conn., assignor by mesne assignments, to Hartford-Empire Co. Filed 4/4/22. The method of producing different size charges from molten glass in a desired order of succession consisting in severing the molten glass as it is discharged from a container, either by the use of a plurality of severing devices operating in different planes, or by a single severing device.

APPARATUS FOR OBTAINING CHARGES OF MOLTEN GLASS. 1,525,191. Feb. 3, 1925. William A. Lorenz, Hartford, Conn., assignor by mesne assignments to Hartford-Empire Co. Filed 4/4/22.



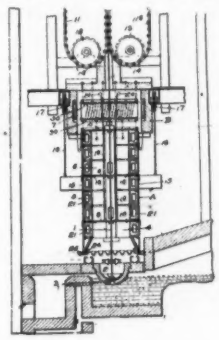
In this method the different size mold charges are obtained from glass discharged and suspended from the outlet of a container by a single severing device operating alternately at the desired levels below the outlet, or in any other order desired.

PLATE-GLASS-TURNOVER FRAME. 1,519,325. Dec. 16, 1924. William Owen, Pittsburgh, Pa., assignor to Pittsburgh Plate Glass Co. Filed 9/11/23.



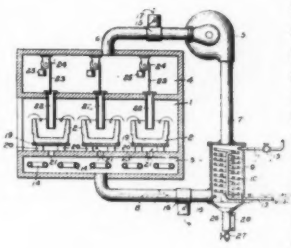
In combination in glass turnover apparatus, a transverse frame, a pair of vertical side members, one of which is mounted for parallel movement toward and from the other member on said frame, and a glass engaging member at the lower end of each side member, said engaging members being swiveled to said side members and slotted to receive edges of sheet.

LEHR FOR ANNEALING SHEET GLASS. 1,525,132. Feb. 3, 1925. Halbert K. Hitchcock, Pittsburgh, Pa., assignor of one-half to Hitchcock Experiment Co. Filed 8/18/21.



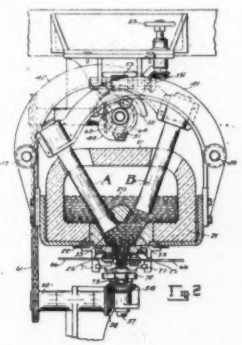
The invention relates particularly to an electric lehr for annealing vertically drawn sheet glass. It covers a casing, means for advancing the glass sheet through the casing, and electrical heating means comprising a plurality of sets of heat coils or turns overlapping each other so that each set heats substantially the same zone in the casing, and means for supplying current through said sets independently of each other, so that the heating effect may be varied by discontinuing the circuit through one or more of the sets.

PROCESS OF DRYING ARTICLES. 1,525,131. Feb. 3, 1925. Halbert K. Hitchcock, Pittsburgh, Pa., assignor to Pittsburgh Plate Glass Co. Filed 3/22/21.



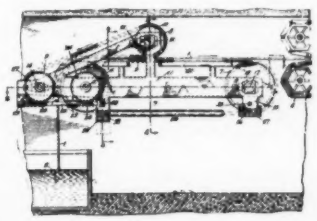
A drying process applied to the drying of clay articles, such as the pots employed in the manufacture of plate glass, comprising a drying compartment or chamber, circulating means whereby the air may be withdrawn from the chamber and returned thereto, means for reducing the humidity of the air as it is circulated; and means for gradually raising the temperature of the circulated air as the drying progresses.

GLASS FEEDER. 1,520,213. Dec. 23, 1924. Leonard D. Soubier and Enoch T. Ferngren, Toledo, O., assignors to the Owens Bottle Co. Filed 10/28/21.



This invention comprises a displacement chamber or container for molten glass provided with an outlet opening in the bottom thereof, a plurality of plungers projecting downward into the glass within the container, means to reciprocate the plungers periodically for controlling the discharge of glass, and means to periodically sever the charges of extruded glass depending from the outlet orifice. Molten glass may be admitted to the displacement chamber through openings in the upper walls thereof, through which the plungers also extend, the flow of glass through said openings being more or less restricted, depending on the position of the plungers.

METHOD AND APPARATUS FOR DRAWING SHEET GLASS. 1,521,294. Dec. 30, 1924. John C. Henderson, New York, assignor to the Libbey-Owens Sheet Glass Co. Filed 10/10/23.



The inventor claims improvement in the art of drawing a continuous sheet of glass from a molten source, consisting in first drawing the sheet upwardly, and then bending the sheet into a substantially horizontal plane, while unsupported except adjacent to its edges, the edge portions which move with the sheet throughout the bending operation, the gripping means at opposite edges of the sheet moving away from one another during the bending operation to apply lateral tension to the glass sheet.

METHOD AND APPARATUS FOR MAKING PLATE GLASS. 1,524,179. Jan. 27, 1925. Floyd V. Kesselman, Butler, Pa., assignor to Frank E. Troutman and Charles H. Christie, Butler, Pa. Filed 7/24/22. The method of making plate glass that comprises depositing a stream of molten glass of substantially uniform cross sectional area upon a pair of cooperating rolls while said rolls are stationary, imparting relative movement as between said rolls and glass in a direction transversely of the flow of glass, and rotating said rolls to extrude the glass between them in sheet form, and apparatus for carrying out the method.

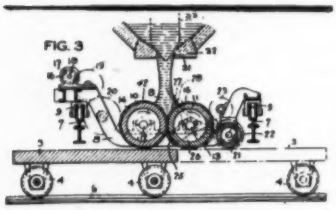


FIG. 3

METHOD AND APPARATUS FOR MAKING PLATE GLASS. 1,524,259. Jan. 27, 1925. Floyd V. Kesselman, Butler, Pa., assignor to Frank E. Troutman and Charles H. Christie, Butler, Pa. Filed 7/24/22. The method of casting and rolling flat glass that comprises delivering molten glass through a downwardly opening outlet in a succession of gobs or gathers, moving a series to extrude the glass between them in sheet form and apparatus annular path to receive said gobs thereon, and rolling said gobs into plates on said tables, and apparatus for carrying out the method.

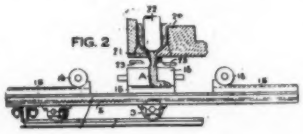
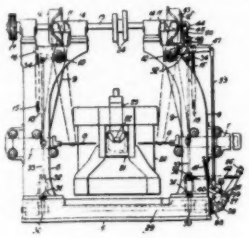


FIG. 2

GLASS-FEEDING MACHINE. 1,524,638. Jan. 27, 1925. Everett O. Miller, Hartford, Conn., assignor to Hartford-Fairmont Co. Filed 4/6/22. A glass feeding machine comprising a plurality of elements cooperating to deliver mold charges of molten glass, having in combination means for independently rendering one of the elements inoperative, and automatic means for returning the element to operative condition at a predetermined time with relation to the operation of the other element or elements.



TURNING PLATE GLASS. 1,524,067. Jan. 27, 1925. Frank E. Troutman and Charles H. Christie, Butler, Pa. Filed 3/17/23. A method of turning flat glass whereby an entire table of glass, consisting of either one large plate or several smaller plates, may be turned in one operation and without changing the relative arrangement of the pieces of glass. The method comprises lifting the pieces of glass simultaneously by means of suction, placing them simultaneously upon a support, placing another support upon said glass, inverting the supports, removing the uppermost support, lifting said pieces of glass simultaneously from the lower support by means of suction, and depositing said glass upon a grinding or polishing table.

Glass Factory Equipment and Supplies

THE GLASS INDUSTRY will be glad to publish descriptions of new and useful devices, machinery and supplies of interest to the glass manufacturing trade. Most of the information printed in this department comes direct from the manufacturers of the products described.

Blowing Equipment for Glass Factories

There are few, if any, industries in which centrifugal fans and blowers play a more important part than they do in this particular field. They can do important service in speeding up production, and in making working conditions tolerable for the men.

Cooling is the prime duty of centrifugal fans and blowers in a glass plant. To this work the American Blower Company, Detroit, Mich., has chiefly applied two types of blowers, the special type P blower and the multiblade Sirocco fan. As this equipment has not previously been described in THE GLASS INDUSTRY a brief account of it will not be out of place at this time.

Type P Blower

This blower is especially adapted to bottle machines for mold cooling. The makers state that it was the first centrifugal type blower applied to this work and rapidly displaced the positive blower which was formerly considered the only type of blower applicable to this purpose.

These blowers are adaptable to bottle manufacture for the following reasons:

The blower is designed for direct connection to either alter-finest quality babbitt metal. They are fitted with special oil-retaining rings, to prevent the oil being drawn out along the shaft by the suction of the air as it enters the inlet of the blower.

The bearings are extra long and ring oiling, lined with the finest quality babbitt metal. These bearings are mounted on cast iron pedestals absolutely independent of the blower housing, thus insuring against vibration being transmitted to the blower housing and making for quiet, smooth operation. The bearings are fitted with special oil-retaining rings, to prevent the oil being drawn out along the shaft by the suction of the air as it enters the inlet of the blower.

The mechanical efficiency of this blower is high. If properly selected, it will show a mechanical efficiency as high as 80 to 82 per cent.

The blower delivers the air to the machine without pulsation, which insures maximum cooling during the length of time the air is delivered to the mold.

When the maximum capacity of the blower is not needed for proper cooling (as in the winter time) the blast gate in the pipe to the machine may be partly closed. This will result in the saving of considerable power without affecting the pressure. This is a decided advantage over the positive blower.

TYPE P BLOWER

The upkeep cost is claimed to be practically negligible.

There are other uses for the special type P blower in a glass plant. It may be used for sheet glass table cooling or for any other work where pressures ranging from 6 to 24 ounces are required.

American Sirocco

This fan is used where large volumes of air at moderate pressures are required.

The Sirocco fan has been used extensively in glass plants for

many years. This fan has practically displaced the old-style paddle wheel fan, formerly used for cooling purposes, and many new and very valuable applications have been discovered. Perhaps one of the most useful applications of this fan is in the cooling of glass tank walls. The glassmaker has discovered that the life of the furnace can be increased if a sufficient quantity of cool air is discharged in the proper manner against the furnace wall.

Some of the principal uses of the Sirocco fan in glass plants are as follows:

Cooling glass tank walls, thus prolonging the life of the tank, saving in upkeep cost and time lost in shutdowns for repairs.

Cooling men working about the furnace lehrs, bottle machines, rolling table, etc.

Cooling molds in semi-automatic and hand machines.

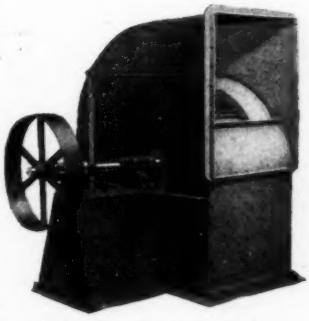
Extensively used in connection with systems for warming portions of plate glass plants to prevent roof condensation.

Utilizing waste heat from glass tanks for heating other buildings. This is accomplished by installing suitable hoods over the tanks and collecting and distributing the heated air from the hot surfaces of the tanks. This performs the double duty of removing heated air from the vicinity of furnaces and utilizing it for heating elsewhere.

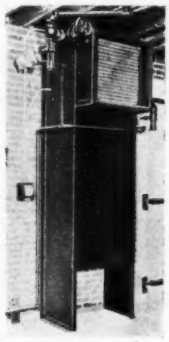
Venturafin Heating Unit

For the heating of working space the Venturafin Heating Unit, having about three times the heating capacity of the original Venturafin Unit Heater, has been placed on the market.

These heaters make use of a peculiar form of tubular construction. The steam tubes are of thin copper, offering little resistance to the passage of heat. Still higher transmission efficiency is given by winding the tubes with a helical brass "fin" which gives them about three times their ordinary heat-radiating surface. Forced circulation of air through the tubes is provided by a motor-driven fan.



AMERICAN SIROCCO FAN



VENTURAFIN HEATING UNIT

The original small unit weighs 320 lbs. and has a capacity ranging from 125,000 to 162,500 B. T. U. per hour, depending on initial and final temperatures. The larger unit delivers from 500,000 to 650,000 B.T.U. per hour and weighs 1060 lbs.

The Venturafin Heating Unit is described in bulletin No. 1218 which will be sent on request to the company.

The American Blower Company has issued a bulletin describing the use of their equipment with special reference to the needs of the glass industry. It is entitled A B C Equipment for the Glass Industry and can be obtained by addressing the company at its main office, Detroit, Mich.

New Automatic Handling Device

A machine of novel design for hacking brick has been put on the market by Luce, Ferry & Heustis, engineers, Brazil, Ind., who state that the principles upon which it operates can be applied to other purposes and who propose to adapt the invention to the automatic handling of bottles and other uniformly shaped glass objects as they come from the automatic blowing machines.

The machine is designed to take articles from a traveling conveyor belt or stationery platform by means of an electrically operated "hand" which grips the article the instant it touches it and elevates it above the belt. The hand is combined with an overhead crane and segregator which allow the objects to be assembled in any desired spaced relation for packing or inspection after being picked up.

The apparatus used for brick hacking consists of an accumulator, suspended from an overhead crane. Rows of gripping fingers are assembled on the bottom of this accumulator.

In operation, the accumulator is moved to a spot above the conveyor on which the "green" brick travel from the brick-

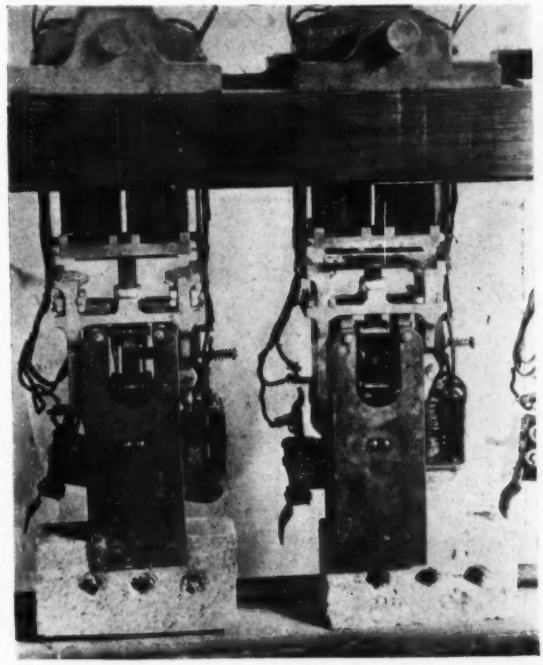


FIG. 1. GRIPPING AND LIFTING FINGERS AS DESIGNED FOR HACKING BRICK

making machine. The first row of grippers has a position immediately above the belt and, as the brick run along, the first one passes to the gripper farthest away, where it is picked up. This process is repeated until the row is loaded, when the accumulator moves over and the process is followed with the next row of grippers. When the accumulator is fully loaded, it is lifted, moved over and the load placed on a truck.

Operation may be either automatic or by a series of push-buttons. The machine is electrically driven, the electrical

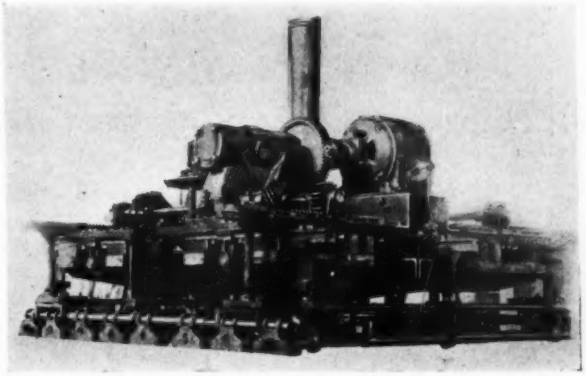


FIG. 2. SEGREGATOR ASSEMBLY WITH GRIPPING AND LIFTING FINGERS OMITTED

equipment being of General Electric manufacture. Five separate motors of various horsepower control the different movements of the machine. The gripping action, however, is magnetic, being operated by a solenoid.

Annealing Bottles in Electric Lehrs

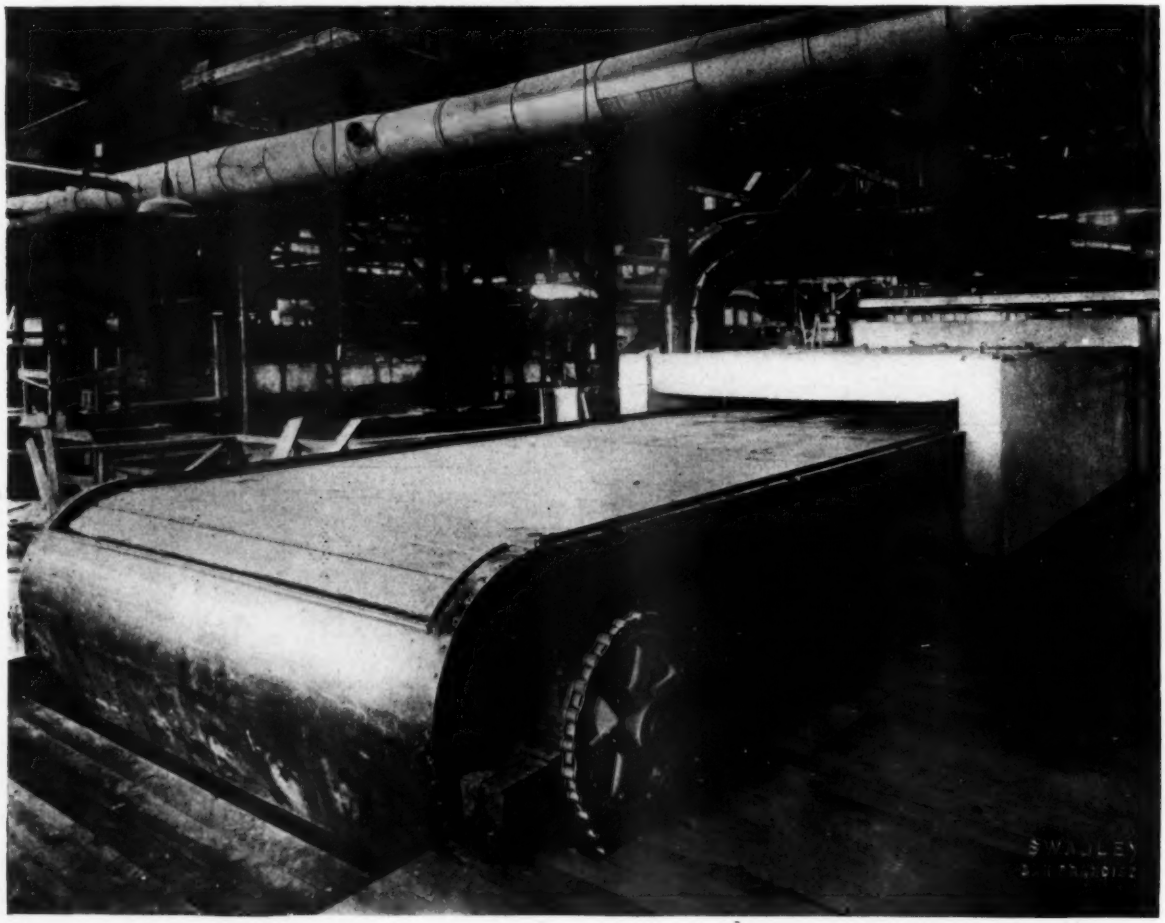
Dissatisfaction with the ordinary methods of annealing led the Illinois-Pacific Glass Company to place in operation in 1921 at their San Francisco plant an experimental electric lehr with a connected load of 125 kilowatts. Close temperature control within narrow limits through the annealing cycle, together with a better quality of output, were the outstanding results.

Since that time, in later installations the size of the electric lehrs has been gradually increased. Two equipments recently purchased by the Illinois Glass Company for use in its Alton, Ill., plant have a connected load of 470 kilowatts each.

The initial installation, one of the first large installations ever made, was designed in cooperation with engineers of the General Electric Company. The electrical equipment for this and subsequent installations is of General Electric manufacture and consists of heating units with an individual automatic temperature control for each temperature zone.

The product annealed by this process is glass bottles. The glass at red heat is carried on a conveyor through a heating zone to equalize the temperature in the glass, and then passed into a lower temperature zone for gradual cooling. That electric annealing is satisfactory is indicated by the fact that customers of the Illinois-Pacific Glass Company insist on the electrically annealed bottles in preference to the old type.

Operating economies of the electrical equipment are said to have been found to compare favorably with the old equipment. Maintenance of the new lehrs is negligible, the upkeep cost of the first experimental lehr being reported as amounting to but fifty dollars for three and one-half years.



THE NEW ELECTRICALLY-HEATED LEHR

New Book

TRAITÉ D'ANALYSES INDUSTRIELLES, by Charles Griffith and Lucien Levi. Preface by J. F. Cellerier. Published by Dunod, 92 Rue Bonaparte (vi), Paris, 1924. Size 6½ x 10 inches, 671 pp. + 119 figs., 5 tables.

The authors of this volume are in charge of the division of analytical chemistry of the National Conservatory of Arts and Crafts of the French Republic. The analytical methods described are those in constant use at this institution. The treatise is confined to methods of testing fuels, building materials, metal and alloys, oils and fats, paints, essential oils, rubber, fertilizer and textile fibres. Chapter VII treats of the analysis of refractory materials and products of the ceramic industry. Chapter VIII is devoted to the glass industry, giving detailed description of the methods of analyzing raw materials entering into glass and of various kinds of glasses, including colored glassware. The chapters on solid, liquid and gaseous fuels are also of special interest to the glass chemist. The authors have succeeded in writing a valuable and readable book. Its study is recommended to chemists actively engaged in the various industries with which the volume deals.

ESTABLISHMENTS IN THE UNITED STATES ENGAGED PRIMARILY IN the manufacture of optical goods reported a total output in 1923 valued at $55,355,161, of which amount $51,450,742 was contributed by spectacles, eyeglasses, goggles, etc., and lenses, frames, mountings, and materials therefor; $1,760,055 by optical instruments and artificial eyes, and $2,144,364 by all other products.

The Glass World and What It Is Doing

News of the Industry

Glass Imports and Exports Decline During 1924

There was a falling off of both imports and exports of glass during 1924. Imports decreased from $24,897,785 in 1923, the highest figure since the war, to $19,171,071, a loss of $5,726,714. Exports declined from $10,964,069 to $8,716,134, a loss of $2,247,935. Since the end of the war imports have mounted from $1,351,522 in 1918 to the 1923 figure. Exports which were worth over $30,000,000 in 1920 have dropped to almost the lowest figure since 1918, this being reached in 1922, viz., $8,650,517.

It is evident that Europe has recovered to a large extent from the devastation and depression due to the war. It also shows that the American manufacturer has been able to lower the cost of production sufficiently to stem the rising tide of importation made possible by a combination of devaluated currencies, lowered standards of living and longer working hours prevailing abroad.

Economies once established tend to have a cumulative effect and may confidently be expected to keep foreign competition in check. Any improvement due to better business conditions at home will then be largely to the advantage of the American producer.

The decline in the importation of plate glass is notable, amounting to over $6,000,000. Imports of window glass declined almost $700,000. Plain glassware, including table glassware, bottles, etc., show an increase in the amount imported of about $600,000. Imports of cut and decorated ware also increased from $1,475,310 in 1923 to $1,937,547 in 1924.

In exports there were declines in all of the four general classifications.

A detailed summary of exports and imports for December, 1924, and for the past year may be found on page 68 of this issue.

Plate Glass Production in 1924

The total production of polished plate glass in the United States, as shown by figures accumulated by P. A. Hughes, secretary of the Plate Glass Manufacturers of America, was 91,554,474 square feet. The production for 1923 was 89,069,441 square feet, showing an increased production in 1924 of 2,485,033 square feet.

The production in 1922 was 76,678,207 square feet and in 1921, 53,578,682 square feet.

The demand for plate glass is good and the outlook for the next six months is excellent. It is estimated that the production for 1925 will be considerably larger than 1924. A substantial increase will be brought about when the new factories under construction get into operation.

While there is every indication that the demand will increase, there will be plenty of glass, as manufacturers have made provision to take care of all requirements.

Feeder Litigation

Miller Glass Engineering Co., through Wm. J. Miller, president, states that the Owens Bottle Co. has filed suit in the Federal Court for the Western District of Pennsylvania against the Miller Glass Engineering Co., charging infringement of Lott Patents Nos. 1,382,993-4 isued June 28, 1921. These patents are alleged to broadly cover the art of feeding glass gobs from a furnace to molds either by means of a reciprocating plunger or by vacuum.

The gob feeder has within the last few years displaced the manual gatherer on nearly all commercial lines of glassware produced in the United States and is rapidly doing so in all foreign countries. Even pressed tableware which a few years ago was produced exclusively on side lever presses is now almost exclusively produced by feeders and high speed automatic machines.

E. A. Lawrence and Green & McCallister, attorneys of Pittsburgh, Pa., who previously represented the Miller Glass Engineering Co. in other patent cases, have been retained for the defense.

Pacific Coast Jobbers Convention

The glass jobbers of the Pacific Coast held their first annual convention at the Biltmore Hotel, Los Angeles, Calif., on February 11 as guests of the glass jobbers and manufacturers of southern California. Besides about 65 delegates from the Coast and Intermountain States there were also invited guests from the glass industry in the East who were in attendance.

During the first day of the convention there were committee meetings following the luncheon, and in the evening a banquet was given to the window glass manufacturers in the music room at the Biltmore. The delegates were welcomed to Los Angeles by Sylvester Weaver on behalf of the Chamber of Commerce. Among the speakers of the evening were B. C. Root, North Storms, Robert H. Raphel and Sam Goodman.

The second day of the convention was given over to visits to local jobbing houses and a trip to Torrance for lunchean and an inspection of the Torrance Flat Glass Company, followed in the afternoon by a visit to the plant of the Western Glass Company at Fullerton. In the evening another banquet was given at the Biltmore. The convention closed on the 13th with a banquet at the Ambassador Hotel.

Pyrometer Patent Litigation Settled

Statements have been issued by both of the principal parties involved in the controversy that the suit brought by Brown Instrument Company in the Federal Court at Chicago against Republic Flow Meters Co. and certain individuals has been settled between the parties; also certain suits at law brought by Republic Flow Meters Co. and the same individuals in the same court against Richard P. Brown have been dismissed.

The officers of Republic Flow Meters Co. did not wish to be under the imputation of illegally using any of the original construction of the Brown Instrument Co. It having been called to their attention that there were pending on behalf of Brown Instrument Co. patent applications covering some of these features, the Republic Flow Meters Co. has changed the construction of its indicating and recording pyrometers announced by it for the purpose of avoiding infringement either of patents or of original designs or construction of the Brown Instrument Co.

Electric Bulb Monopoly Charged

Arguments in the case of the United States Government against the General Electric Company, Westinghouse Electric & Manufacturing Company and the Westinghouse Lamp Company, alleged to have violated the Sherman Law, were heard by Federal Judge David C. Westenhaver at Cleveland, O. The Court's decision was reserved.

It was asserted that the arrangement existing among the defendants was in restraint of trade, competition being eliminated. The attorneys for the defense, however, claimed that because of its ownership of patent rights, the General Electric Company enjoys a monopoly of the manufacture of bulbs and has the right to distribute them in any way it may see fit. The Court's decision is awaited with great interest.

Society of Glass Technology Nominations

The eighth annual meeting of the Society of Glass Technology will be held on April 22, 1925. The election of officers for the ensuing year will take place. The Council has issued a list of the members it has nominated to fill the vacancies falling due in April, as follows:

President, T. C. Moorshead; vice-president, W. Butterworth, Jr., and J. H. Davidson; ordinary members of Council, B. P. Dudding, E. A. Hailwood, H. J. C. Johnston, Ed Meigh, and G. Simpson; treasurers, Joseph Connolly, and Wm. M. Clark (American); honorary secretary, Prof. W. E. S. Turner.

Ceramists Invited to Visit England

At the meeting of the Society of Glass Technology on January 21 at the University, Birmingham, it was resolved to invite the members of the American Ceramic Society to visit England during the coming summer.

It was also resolved to invite the Belgian members of the Society of Glass Technology to pay a return visit to England in May.

Ford May Make Glass at St. Paul

Officials of the Ford Motor Company recently declined to confirm reports in circulation concerning their intention to establish a glass works as part of their new plant at St. Paul, Minn., characterizing the rumors as premature.

It is however known that serious consideration, to say the least, has been given to the project of producing plate glass there and that plans for such a factory are being prepared.

Trade Activities

The Toledo Engineering Company, Toledo, O., glasshouse engineers and contractors, are now located at 427-29 Nasby building.

The Weston Glass Company, Weston, W. Va., have completed repairs to their glass tank which burst early in the year and have resumed operations.

The American Window Glass Company resumed operations at their New Eagle, Pa., plant the latter part of February after being shut down since April, 1924.

The Glass Novelty Company, 1915 West 19th street, Chicago, Ill., will construct a two-story factory, 80 by 500 ft., at 4400 West 26th street, to cost about $95,000.

The Le Flore Glass Company, Poteau, Okla., state that reports that they would install Fourcault drawing machines are premature as they have made no definite plans along that line.

The Tiffin Cut Glass Company, Tiffin, O., was reorganized on January 24 at a special meeting of the stockholders, and decided to operate under the same name as a partnership, instead of as a corporation.

The Macbeth-Evans Glass Company's No. 1 department at Charleroi, Pa., resumed operations early in February under the supervision of the new superintendent, W. D. Pollock. About seventy-five persons were given employment.

The Opal Glass Products Company, Millville, N. J., recently organized to manufacture opal towel holders, etc., began operations at their new factory about the middle of February. LeRoy Duke is president of the firm and Harry Matthews, manager.

The Central Glass Company, manufacturers of mirrors, glass dealers, etc., Evansville, Ind., are now operating their new plant at Fulton avenue and Belt Railroad which was built at a cost of about $35,000 to replace the factory destroyed by fire several months ago.

The Lippincott Glass Company, Alexandria, Ind., announces that it is operating under a receivership as a result of a claim brought by the Simplex Engineering Company, the Superior Court of Anderson, Ind., having appointed H. M. Adams and S. G. Phillips as receivers.

The Star Glass Company's creditors and holders of liens have been given official notice to present on or before March 16 all claims to the Commissioner in Chancery, Frank P. Weaver, Morgantown, W. Va. The company's plant is located at Star City, W. Va.

The Coshocton Glass Company, Coshocton, O., according to a press report, has resumed operations after a six months' shut-down, and in addition to tumblers and nappies previously manufactured will produce a few new lines such as candlesticks, fruit and bulb bowls, etc.

The Eden Glass Company, Clarion, Pa., has applied for a Pennsylvania State charter, the incorporators including: A. J. Rose, C. L. Clover, R. R. Underwood and others. The company will manufacture, buy and sell glass and glassware, corks, laboratory glassware, etc.

The old plant of the Martins Ferry Box & Barrel Company, Martins Ferry, O., which manufactured barrels and containers for glassware, etc., but which has been operated lately by **H. Bettis & Company,** Wheeling, W. Va., was recently destroyed by fire with an estimated loss of about $10,000.

The Gulf Plate & Window Glass Company, Houston, Tex., to deal in plate, window and polished wire glass, etc., has been organized by Hugh Banner, formerly with Binswanger & Company, Memphis, Tenn., and J. H. Knight, of the United Plate and Window Glass Company, Oklahoma City, Okla.

The Bonita Art Glass Company, who recently moved their plant from Wheeling to Huntington, W. Va., have completed the installation of decorating ovens, made necessary additions and began operations on March 1. William Schwartzbach, formerly of Pittsburgh, is to be in charge of the decorating department.

Creditors of the **Newborn Glass Company,** Royersford, Pa., have made application for the appointment of a receiver to take charge of assets. Josiah H. Marvis, Philadelphia, Pa., attorney for the creditors, announces the action was made necessary due to several judgments about to be given preference.

The Upland Flint Bottle Company, Marion, Ind., through W. C. Forbes, secretary, announces that contrary to press reports they have decided not to open their old Upland glass factory at present. The building was vacated when the plant moved to larger quarters in the old Standard glass factory at North Marion.

The Poulas Cut Glass Company, Lancaster, O., through W. S. Graham and Thomas Poulas, according to a press report, made a proposition to the Chamber of Commerce of Circleville, O., to move their plant to that town provided the citizins guarantee them a bonus, and also donate land and a factory building.

The Woodbury Glass Company, Winchester, Ind., was temporarily closed down early in February when one of the tanks burst due to the stoppage of the flow of water in the cooler at the throat of the furnace. Another tank which had been down for repairs was immediately fired, with the expectation of resuming operations in about three weeks.

Walter Forster, joint managing director of the Forster's Glass Company, Ltd., St. Helens, England, who operate one of the largest bottle factories in that country, arrived in New York about the middle of January and has been making a tour of glass factories, visiting various sections of the country in order to familiarize himself with the latest American practice.

The Hazel-Atlas Glass Company, Wheeling, W. Va., in a preliminary statement issued previous to the annual meeting showed that net profits of $931,652 for 1924 would be reported. During the year $789,901 was expended for maintenance and improvements and $536,773 charged off for depreciation. The surplus at the end of the year was $1,853,816 compared with $1,835,324 on January 1, 1924.

Officials of the **Citizens Glass Company,** Barnesville, O., recently visited the Quertinmont Glass Company, Fairchance, Pa., and inspected the Fourcault sheet glass drawing machines in operation there, with a view to the possibility of installing that system in their own plant. A meeting of the stockholders of the company was held on February 16 for the purpose of acting upon a proposal to increase the $100,000 bond issue already authorized to $300,000.

The stockholders of the **Inland Glass Company,** Chicago, Ill., at the annual meeting held February 18, elected the following directors: Robert P. Lamont, president, American Steel Foundries; George E. Marcy, president, Armour Grain Co.; John J. Mitchell, Jr., Illinois Merchants Bank; William H. Mitchell, president, Mitchell Hutchins Co.; John T. Pirie, Carson, Pirie, Scott & Co.; John H. Rodger, vice-president, Safety Car Heating & Lighting Co.; Philip K. Wrigley, president, William Wrigley, Jr., Co.; Cornelius J. Nolan. The following officers were elected: President, Cornelius J. Nolan; vice-president, John J. Mitchell, Jr.; Secretary and treasurer, Noble Brandon Judah. Under the management of Mr. Nolan for the past six months the business has shown a decided improvement and is running to full capacity. The output has been increased approximately 100 per cent and the volume of business in sight for the current year threatens to over-tax the capacity of the plant. The product is mostly illuminating

glassware, with the exception of glass cylinders for gasoline pumps, and railroad globes and lenses.

Recent Deaths

Dr. W. F. Hillebrand

Dr. W. F. Hillebrand, Chief Chemist of the Bureau of Standards since 1908 and formerly Chief Chemist of the United States Geological Survey, died on February 7 following a surgical operation. He was 70 years old. Among his contributions to chemistry the most notable is his treatise entitled "The Analysis of Silicate and Carbonate Rocks," which is generally considered as the fundamental source of information regarding silicate rock analysis. The volume, which has been reprinted repeatedly, is an invaluable aid to glass chemists.

The deceased studied at Cornell University and took the degree of Doctor of Philosophy at Heidelberg in 1875.

Coming Meetings

NATIONAL ASSOCIATION OF MANUFACTURERS OF PRESSED AND BLOWN GLASSWARE will hold its annual meeting at Pittsburgh, Pa., on March 10.

FIRST CHEMICAL EQUIPMENT EXPOSITION will be held at Providence, R. I., June 22 to 27, 1925, under the auspices of the Association of Chemical Equipment Manufacturers, 1328 Broadway, New York.

NATIONAL ORNAMENTAL GLASS MANUFACTURERS' ASSOCIATION will hold its annual convention in Pittsburgh, June 24 to 26, 1925.

AMERICAN FLINT GLASS WORKERS' UNION, annual convention will be held the first week of July, 1925, in Toledo, O.

TENTH EXPOSITION OF CHEMICAL INDUSTRIES will be held at Grand Central Palace, New York, September 28 to October 3, under the management as usual of the International Exposition Company, 480 Lexington Ave., New York.

What Our Advertisers Are Doing

THE CHAPMAN-STEIN FURNACE CO., Mt. Vernon, O., has received orders from the Owens Bottle Co. for two Chapman-Stein recuperators for revolving pot furnaces at their Glassboro, N. J., plant. This company is already operating eight of these recuperative furnaces.

A Chapman-Stein recuperative two-pot furnace at the Pittsburgh Plate Glass Co. plant at Charleroi, Pa., replaces two single pot furnaces used for the manufacture of special glass. On the single pot furnaces the fuel consumption was from 65,000 to 70,000 cubic feet of natural gas per pot, while on the recuperative furnaces the fuel consumption is slightly less than 28,000 cu. ft. per pot. The pots are 54" in diameter and are of the open type.

THE AMSLER-MORTON COMPANY has closed contracts with the Illinois Glass Company for seven 9 x 65 ft. Amco lehrs, two type C lehrs to be constructed at Alton, Ill., and five type B for the Bridgeton, N. J., plant.

In addition to the above the Company has contracts covering four high duty tanks, two recuperators, and two type C lehrs for the Vidriera Monterey, Monterey, Mexico.

Also one decorating lehr for Zeh Incorporated, Clifton, N. J., a decorating lehr for the Dunbar Flint Glass Company, Dunbar, W. Va., also to change two lehrs to the Amco type for the Economy Glass Company, Morgantown, W. Va.

Since constructing the first Amco recuperator on a 14 x 18 ft. continuous tank for the Carr-Lowry Glass Company, Baltimore, Md., contracts have been closed with the Columbia Glass Company and the McLaughlin Glass Company, of Los Angeles, Cal., and the Victory Glass Company, Jeannette, Pa., for recuperators in connection with continuous tanks, two for the Vidriera Monterrey, Monterrey, Mexico, and three for the Illinois Glass Company, Bridgeton, N. J., for use with revolving pots. One 8 x 65 ft. C type lehr for the Fairmount Glass Works, Indianapolis, Ind., and five lehrs for Swindell Brothers, Baltimore, Md.

They will construct a glass melting tank and one type C lehr for the Decamp Consolidated Glass Casket Company, Muskogee, Okla., and two type C lehrs for the Vidriera Fenecia, Bogota, Colombia, South America.

Four lehrs for the Capstan Glass Company, Connellsville, Pa., will be changed to the C type to permit the use of lehr feeders.

The two B type lehrs for the Greensburg Glass Company, Greensburg, Pa., which were contracted for some time ago, are about completed and construction of one C type lehr for the Corning Glass Works, Corning, N. Y., has been started.

The Amsler-Morton Company also reports the equipping of several plants with the Amco fuel oil systems including three plants of the Standard Sanitary Manufacturing Co., Pittsburgh, Baltimore and Louisville works.

Inquiries Received

247. G. Muntz, president, Tropenas Company, Cunard building, 25 Broadway, New York, advises that J. Vigne, manager of their Brazilian glass works, employing 3,000 hands, will be in this country the latter part of March to purchase equipment and to study the improvements in the industry since his last visit, five years ago. Mr. Vigne is interested in everything connected with the glass industry, as he produces bottles of all sorts and window glass. To save time, Mr. Muntz suggests that all those who have something to sell, whether supplies, machinery, patents or processes, send full information in triplicate, and that letters and catalogs also should be in triplicate. (Feb. 10.)

248. Who manufactures pneumatic conveyors for unloading soda ash and other materials from cars? Also who makes drag type car unloaders? (Feb. 9.)

249. Can you give me the names of concerns building oval beveling machines? (Feb. 4.)

250. We would like the names of glass factories specializing in molded ware, especially glass insulators. (Feb. 5.)

251. Can you recommend an expert competent to inspect and report fully for a foreign concern on some glass-making machines located at Pittsburgh? (Feb. 11.)

252. Can you give me the names of manufacturers of machinery for blowing and pressing small articles, and also for polishing and grinding? (Feb. 14.)

253. We are in the market for exhaust fans. (Feb. 17.)

254. Where can we obtain machinery for making a new electric light bulb for which we control the patents. (Feb. 24.)

What the World Wants

Specific inquiries for American goods received in the United States Department of Commerce.

Numbers prefixed to the items refer to confidential information which may be obtained by concerns listed in the Exporters' Index by applying to the nearest district office of the Bureau of Foreign and Domestic Commerce, or to headquarters at Washington, D. C. Mention the number of the inquiry in which you are interested.

To become listed on the Exporters' Index, it is necessary to fill out a form (Form 57), which may be had upon application to the Bureau or its district or co-operative offices.

Poland. 13,601, surgical glass.
Colombia. 13,708, glass bottles, 5-grams; glass stoppers enclosed in cartons.
England. 13,717, cathedral, variegated glass and glass novelties.
Rumania. 13,733, electric light bulbs, chiefly 50 candlepower.
Italy. 13906, machinery for the manufacture of window glass.

Stock Quotations

(Reported by Moore, Leonard & Lynch, Union Trust Bldg., Pittsburgh, Pa.)

PITTSBURGH STOCK EXCHANGE, FEBRUARY 20, 1925

	Bid	Ask	Last
American Window Glass Machine, common	96	97	97½
American Window Glass Machine, pfd....	97	99	100
American Window Glass, preferred.....	115	..	114
Pittsburgh Plate Glass	280	288	280
U. S. Glass	17½	19½	18
Standard Plate Glass, common.....	13	13½	13¼
Standard Plate Glass, preferred—			
Cumulative	..	75	76
Prior	..	95½	94¾

Glass stocks on the Pittsburgh Stock Exchange ruled higher on increased activity in the past month. An aggregate volume of building in 1925 somewhat under that for 1924, but a building total for the early months of the year, practically on a par with a year ago, are now forecast. As soon as weather conditions permit of more active construction work, movement of materials to consumers should reach a volume commensurate to that of last Spring. No new records are anticipated, although well sustained activity with attendant firm prices are in prospect. Moderate advances are likely in the first part of the year. Inventories of the majority of companies run normal to depleted, which further strengthens the situation.

WHEELING STOCK EXCHANGE, FEBRUARY 20, 1925

	Bid	Ask	Last
Hazel-Atlas	..	32½	32½
Imperial	75	80	85
Fostoria	140	..	140
Central	..	95	98

The Wheeling market did not display much activity during February.

TOLEDO STOCK EXCHANGE, FEBRUARY 20, 1925

	Bid	Ask	Last
Owens Bottle Machine, common.....	45¾	46¼	46
Libbey-Owens Sheet Glass, common.....	108	111	109
Libbey-Owens Sheet Glass, preferred.....	107	111	109

Current Prices of Glass-Making Materials

Quotations furnished by various producers, manufacturers and dealers.

February 20, 1925		Carlots	Less Carlots
Aluminum hydrate ($Al(OH)_3$)	lb.	.05	.05½
Aluminum oxide (Al_2O_3)	lb.	..	.07
Antimony oxide (Sb_2O_3)	lb.	..	.17½
Arsenic trioxide (As_2O_3) (dense white), 99%	lb.	.05¾	.06¼
Barium carbonate ($BaCO_3$)			
Precipitated	ton	..	..
Natural, powd.	ton	50.00	55.00
Barium hydrate ($Ba(OH)_2$)	lb.	..	.05½
Bone ash	lb.	.06	.07½
Borax ($Na_2B_4O_7 10H_2O$)	lb.	.04¾	.05
Borax, fused ($Na_2B_4O_7$) any mesh.	lb.	.14½	.16½
Boric acid (H_3BO_3)	lb.	..	.08½
Boric acid, refined	lb.	.09	.09½
Cadmium Sulphide (CdS)—			
Red	lb.	..	1.35
Orange	lb.	..	1.45
Yellow	lb.	..	1.75
Chrome Oxide (Cr_2O_3)	lb.	..	.34
Cobalt Oxide (Co_3O_4)—			
In bbls.	lb.	..	2.10
In 10 lb. tins	lb.	..	2.20
Copper oxide—			
Red (Cu_2O)	lb.	..	.23
Black (CuO)	lb.	..	.25
Black prepared	lb.	..	..
Cryolite (Na_3AlF_6)	lb.	..	.09⅛
Feldspar—			
100 mesh	ton	13.00	..
80 mesh	ton	12.00	..
40 mesh	ton	12.00	..
Ferric oxide (Fe_2O_3)	ton	..	..
Fluorspar (CaF_2)—			
Powdered white, 95%	ton	45.00	50.00
Hydrochloric acid (20°) (Carboy $5)	lb.	..	.01
Hydrofluoric acid (HF) 60% (in lead carboys)	lb.	..	.13-.13½
52% and 48%	lb.	..	.10-.11½
Kaolin (f.o.b. mine)	ton	10.00	..
Ex vessel	ton	18.00	..
Lead Oxide (Pb_3O_4) (red lead)	lb.	.13½	.13¼
Litharge (PbO)	lb.	.12¾	.13
Lime—			
Hydrated ($Ca(OH)_2$) (in 50 lb. paper sacks)	ton	12.50	..
Burnt (CaO) ground, in bulk.	ton	9.00	..
Burnt, ground, in paper sacks.	ton	12.00	..
Burnt, ground, in 280 lb. bbls. per bbl.		2.15	2.30
Magnesium carbonate ($MgCO_3$)	lb.	..	.08
Manganese 85% (MnO_2)	lb.	.03½	.03¾
Nickel oxide (Ni_2O_3), black, for nickel content	lb.	..	.35
Nickel monoxide (NiO), green, for nickel content	lb.	..	.35
Nitric acid (38°) (Carboy $5)	lb.	..	.04¼-.05
Potassium carbonate—			
Calcined (K_2CO_3) 96%	lb.	.06¾	.07
Hydrated 85%	lb.	.05¾	.06
Potassium nitrate (KNO_3) (gran.)	lb.	.06	.06¼
Potassium permanganate ($KMnO_4$)	lb.	.15	.16
Powdered blue	lb.	..	.24
Standard formula	lb.	..	..
Rochelle salts	lb.	..	.20
Salt cake, glassmakers (Na_2SO_4), f.o.b. works	ton	22.00	..
Selenium (Se) black, powd.	lb.	..	2.10
Silver nitrate ($AgNO_3$) 100 oz., per oz.		..	.46⅛-.48⅜
Soda ash (Na_2CO_3) dense, 58%— f.o.b. works.		..	..
Bulk, spot	Flat 100 lb.	1.35-1.40	..
Bulk, on contract	Flat 100 lb.	1.35	..
In 400 lb. bbls., on contract.	100 lb.	1.69	2.40
In 400 lb. bags, on contract.	100 lb.	1.45	..
Spot orders .05 per 100 lbs. higher.			
Sodium nitrate ($NaNO_3$),			
Refined (gran.) in bbls.	lb.	.03½	.03¾
95 per cent.		.02⅝	.02¾
Sodium selenite (Na_2SeO_3)	lb.	..	2.35
Sodium fluosilicate (Na_2SiF_6)	lb.	..	.05-.05½
Sodium uranate (Na_2UO_4)	lb.	..	1.45
Sulphur (S)—			
Flowers, 155 lb. bbl.	Per 100 lb.	3.35	3.65-3.90
Flowers, in bags	Per 100 lb.	3.00	3.30-3.55
Flour, heavy, in bbls.	Per 100 lb.	2.40	2.85-3.05
Tin oxide (SnO_2) in bbls.	lb.	..	.61
Uranium oxide (UO_3), 100 lb. lots.	lb.	..	1.35
Zinc oxide (ZnO)	lb.	.08	.08¼

Monthly Summary of United States Foreign Commerce in Glass

EXPORTS

Corrected to January 23, 1925

	December 1923 Quantity	December 1923 Value	December 1924 Quantity	December 1924 Value	Twelve Months Ending December 1923 Quantity	Twelve Months Ending December 1923 Value	Twelve Months Ending December 1924 Quantity	Twelve Months Ending December 1924 Value
Glass and glass products (total)	.....	$837,257	.....	$626,287	.....	$10,964,069	.....	$8,716,134
Plate and window glass—								
Window glass, common, box 50 sq. ft.	10,080	35,440	2,556	11,682	50,682	256,243	41,536	186,986
Plate glass, unsilvered, sq. ft.	148,181	55,503	205,356	41,055	1,981,767	843,792	1,809,300	516,163
Other windows and plate glass, n.e.s. lbs.	225,977	21,272	199,380	18,506	3,397,376	375,412	2,105,976	221,268
Glass containers (bottles, vials and jars) lbs.	4,502,481	236,216	4,070,812	212,713	73,025,439	3,503,671	60,146,480	2,874,979
Table glassware, plain lbs.	1,486,192	175,569	1,099,673	124,637	20,616,277	2,278,202	16,355,229	1,764,556
Table and other glassware, cut or engraved lbs.								
Glass for lighting—	96,531	19,038	35,421	14,378	612,001	215,345	546,858	169,597
Lamp chimneys and lantern globes lbs.	195,259	35,913	164,166	25,925	2,044,557	393,981	1,931,153	353,334
Globes and shades for lighting fixtures lbs.	140,530	32,078	92,762	31,734	1,638,827	468,114	1,369,393	400,791
Lamps and other illuminating devices, chiefly of glass lbs.	157,048	32,695	88,425	23,781	1,606,590	395,058	1,026,545	304,764
Chemical glassware	19,420	14,381	15,928	11,803	247,443	175,801	238,195	190,666
Electrical glassware, except for lighting lbs.	162,216	17,728	75,336	9,161	2,665,704	184,276	2,390,662	241,558
Other glassware, n.e.s. lbs.	1,264,808	161,024	371,138	100,912	10,869,337	1,874,174	8,281,985	1,491,472

IMPORTS

Corrected to January 23, 1925

Glass (total)	.....	$2,021,616	.....	$1,155,620	.....	$24,897,785	.....	$19,171,071
Cylinder, crown and sheet lbs.—								
Unpolished, lbs. dut.	3,470,640	197,332	2,049,078	109,709	46,647,495	2,125,730	30,483,415	1,743,144
Bent, ground, beveled, colored, painted, etc., and polished dut.	.....	61,199	.....	34,391	.....	791,788	.....	511,789
Plate glass—								
Unsilvered, sq. ft. dut.	1,968,348	1,318,755	963,682	451,089	26,267,476	16,046,805	16,797,965	9,912,912
Fluted, rolled, etc., or silvered, or containing wire netting, sq. ft. dut.	181,894	31,078	188,735	32,992	2,152,816	368,737	2,575,353	366,691
Containers—bottles, vials, etc. dut.	.....	13,000	.....	14,174	.....	198,367	.....	206,942
Table and kitchen utensils, lbs. dut.	53,596	10,472	23,318	5,589	655,438	168,866	865,089	200,883
Glassware, cut or decorated, lbs. dut.	233,340	135,950	288,781	177,125	3,562,575	1,475,310	3,976,772	1,937,547
Blown glassware, n. e. s., lbs. dut.	303,601	98,564	.....	.....	6,252,178	1,459,392	.....	.....
Bottles, ornaments, etc., lbs. dut.	.....	.....	293,112	102,587	.....	.....	6,473,797	1,874,397
Bulbs or electric lamps, number dut.	.....	.....	1,129,238	12,313	.....	.....	15,872,658	219,287
Chimneys, globes, shades, etc., lbs. dut.	.....	.....	502,536	110,702	.....	.....	4,691,854	932,683
Articles and utensils for chemical, scientific, and experimental purposes, lbs. dut.	.....	.....	53,798	21,683	.....	.....	970,501	332,161
Other glassware { free	.....	155,266	.....	83,266	.....	2,262,790	.....	932,635
Other glassware { dut.								